THE NUTRITION OF A HOUSEHOLD

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"*Human progress consists in the gradual and partial substitution of science for art, of the power over nature acquired in youth by study, for that which comes in late middle age as the result of experience.*"

GRAHAM WALLIS.

PREFACE

THERE is nothing new in this book. A housekeeper getting twenty-one meals a week with her own hands, a householder whose natural masculine interest in machines has extended to the stoking of his own bodily engine, have set down so much of the modern theory of animal nutrition as they have themselves found it practically convenient to know. We found ourselves asking various questions. We turned to Lusk and Voit and Rubner and the United States Department of Agriculture for the answers. Here, in brief, they are.

We have, then, no new theory; we attempt to persuade no one to any course of action. We have simply boiled down the information that is in every modern textbook, and put it into form for the non-technical reader.

Our only apology for writing the book at all is that, unlike various of our contemporaries, we have not attempted to straddle be-

tween familiar words and time-honored ideas on the one hand, and modern chemical physiology on the other; but have frankly put the new wine into new bottles and let it go at that.

The actual text grows out of two series of short articles, one in the *Delineator*, the other in the *Woman's Home Companion*, together with various sporadic essays and book reviews in the *Atlantic Monthly*, the *Metropolitan*, the *Associated Sunday Magazines*, the *Boston Transcript*, and elsewhere. But the growth has been quite beyond the parental ken; and except for an occasional paragraph, the book is entirely new.

Our especial thanks are due to Mr. James E. Tower, associate editor of the *Delineator*, for his first suggestion that we should make a book and for his expert advice on what the public wants.

L. B.

CONTENTS

THE NUTRITION OF A HOUSEHOLD

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I

THE HUMAN MACHINE

THE present-day efforts of science to ameliorate the condition of the eating classes really go back to about 1840. Within the memory of women who are still keeping house, the learned world had nothing to tell the mother of a family concerning her dealings with butcher and baker. If the family cook fed her household by immemorial tradition and rule of thumb, the most scientific head of the largest public institution was no better off. Chemist, physiologist, farmer with stock to fatten, woman with human beings to feed, all were in the same boat. Nobody really knew what food is for.

General opinion had it that the work of the body is not done on its food. A mysterious

"vital force" was supposed to animate the body and to move the muscles. Heaven supplied us at birth with enough to last us throughout our days, and every stroke of work during the longest life was done on this original supply. Each of us was a storage battery charged for a lifetime, a clock wound up for eighty years. But who wound the clock, and just where under our waistcoats we carried this enormously powerful dry-cell was precisely "one of those things that no fellah can find out."

Nor was the object of the alimentary intake generally thought to be to keep the body warm. "By some," remarks a standard medical work of the eighteen-forties, this bodily heat "has been regarded as the product of effervescence of the blood and humours; by others, as owing to the disengagement of an igneous matter or spirit from the blood; by others to an agitation of the sulphureous parts of the blood; whilst Boerhaave and Douglas ascribe it to the friction of the blood against the parietes of the vessels, and of the globules

against each other. In favour of the last hypothesis —" But one need not go on. The point is that what we now know to be the one chief object and function of all the solid food that we put into our mouths, namely, to serve as fuel for the bodily engine and drive the human machine through its day's work, had hardly occurred to anybody seventy years ago.

On the other hand, mankind has known from the earliest times, usually from bitter experience, that whoso goes hungry, grows also weak and finally dies. But why he weakens, and what he dies of, were again a part of the unsolved mystery of existence.

Common opinion, however, came down to about this: Most things, left alone, fall into decay and disappear. Obviously that is true of the animal body when once the animating spark has departed from it. How simple, then, to suppose that this same decay is going on all the while during life, and that the one and only object of roast and loaf is, as the phrase went, "to restore the waste of tissue."

In other words, we leave the family motor-car out in the rain long enough, and it falls apart into a heap of mouldy leather and rusty steel. Evidently, then, we feed the machine on gasoline in order to repair this wasted substance. The gasoline does not drive the wheels; that is accomplished by mysterious and unknown "mechanical force" which the maker put into the car before it left the shop. The cylinders grow hot merely by the friction of their pistons. The gasoline, in some unknown way, is transformed into rubber and brass to replace the worn-out members. Such in modern terms was the reasoning of the pre-Victorian physiologists concerning the living automobiles in which we travel through our day's work.

It would not be worth while to dwell at such length on this long exploded error, were it not that the same old superstition still lingers in the public mind. We know better. We have read the housekeeping magazines. We have studied physiology at school. Yet for some reason, the old idea clings, that the great ob-

ject of food is to replace outworn portions of the body — that the food is the duplicate parts and the spare tire which the prudent automobilist carries along on his seventy-year journey from cradle to grave. Food is, to be sure, in part that; but at least nineteen-twentieths of what we pay for is actually used simply as gasoline to drive the engine, not as spare parts to mend breaks. So we, too often, telephone to the butcher shop for an expensive new tire, when what we really need is another gallon of oil from the bake-shop or the grocery.

Any housekeeper, therefore, who wants to take advantage, let us say, of the present-day work of the United States Department of Agriculture in its endeavor to counter on the high cost of living, and to feed her family well without spending more than she can afford, must first of all clear her mind of this old repairing-the-waste-of-tissue superstition. Of course, if we had never eaten anything, we should n't be here now. But practically we neither live to eat nor eat to live: we eat to

work. For all practical purposes, a nutritious food is one that drives the bodily engine. That is the one great contribution of modern science to household economy.

To be sure, three quarters of the driving energy which in very differing amounts is locked up in each pound of mutton chop or watermelon or apple pie, ready for any one with work to do to digest out and use, goes simply to keeping us warm, to pumping our blood, and to sucking air into our lungs. Only a small part of our day's "work" is anything that we can decently ask pay for doing. But work it all is in the scientific sense; and any food is "nutritious" simply in proportion to the "work" of nerve or gland or muscle that we can make it do.

When all is said, then, our bodies are simply human motor-cars. They are built of flesh and bone instead of steel and leather. They run on bread and butter instead of gasoline. They have a million cylinders in place of six, and the least of their parts is more complex in its structure than all the automobiles that ever came

out of Detroit. But, at bottom, they are explosion engines, which our souls, sitting at the steering-wheel under our hats, guide through seventy years of work — and then, let us hope, change for an improved model.

II

THE FALLACY OF LIEBIG

THE man who had most to do with breaking through the old doctrine of "vital force" was the great Baron von Liebig. Liebig picked up an idea of Lavoisier — which the French chemist himself would most probably have worked out if the reformers of his day had not cut off his head during the Revolution — the idea that the heat of the body comes simply from the burning of the food. Lavoisier was in the main right; and even in part proved his case by showing that the quantity of ice which a guinea pig could melt by the warmth of its body had a pretty close relation to the amount of carbon dioxid which it gave off from its lungs, or in other words, to the amount of food that it was using up. Lavoisier, however, supposed that this combustion takes place in the lungs — an opinion which still lingers in the popular mind, and even occasionally finds its way into print.

Liebig, then, starting with this idea of Lavoisier, was able to prove what the older man of science had only believed; and to show, in addition, that the combustion of the food takes place, not particularly in the lungs, but in all the tissues of the body, and most especially in the muscles.

This done, it was but a short step to the opinion, that not only the heat of the body, but likewise all its work is done by the combustion of the food. Another step, equally short, brings us to the strictly modern view that the food consumed in the body yields, in general, the same amount of heat and work as if it had been dried and burned under the boiler of a steam engine or exploded in the cylinder of a motor-car. The "nutrition" of food, then, is precisely the same thing as the nutrition of coal or gasoline — the ability to get itself oxidized and to do work.

These steps Liebig took, about the middle of the century, and forthwith the entire scientific world came trailing after him. His basal idea has never been questioned since.

At one point, however, Liebig's theory, thoroughly sound in the main, erred through excess of logic. We human beings are made up largely of muscle. The muscle as it works uses up its substance. Let us, then, study the chemical nature of muscle. Those foods which are most like muscle will best replace the wasted substance and be most nutritious.

Therefore, wrote Liebig in effect, a workingman at hard labor should eat oat bread rather than wheat because oats chance to be, chemically, slightly more like flesh. Most of all should a workingman eat much meat, because meat is of all foods most like the tissue of his own muscles.

On the other hand, argued Liebig, if one is to endure cold, he must eat such foods as most resemble the substances which we actually do use to warm our houses, namely, the fats, sugars, and starches. These will burn up in the body and keep us warm, whether we work or rest. Foods, therefore, said Liebig, are of two kinds — the blood-making or flesh-building foods which repair the tissue which is

destroyed when we do work, and the heat-yielding foods which merely keep us warm. "Elements of Nutrition" and "Elements of Respiration" were Liebig's names for the two.

All this, I say, was most logical. In other words, a motor-car is built of steel, leather, rubber, and wood, mostly of steel. As the car is used, it wears out. Therefore the proper fuel for a motor-car is something as nearly as possible like iron. Evidently gasoline is merely a "fuel-food," an "element of respiration," good to keep the feet warm, but no use at all to push the load uphill.

An obvious experiment knocked this *Liebigschen Theorie* higher than an aeroplane. Voit, in 1866, among others who did not agree with Liebig, simply took a man, measured his food or let him go hungry, measured the muscular work of nine hours a day on a treadmill, and by analyzing the waste of lung and kidney determined just how much of one was going into the other. It transpired forthwith that when the subject of the experiment changed from rest to labor, the consumption of "fuel-

foods" changed in precisely equal measure, but the consumption to "tissue-building" foods remained exactly the same. The severe labor used up fat, not muscle.

In other words, the man did his work entirely on his "elements of respiration," and not at all on his "elements of nutrition." That is to say, "nutritious" foods are precisely those which are *not* like the living substance of the body. So even Liebig himself changed his mind. He had taught the world what "nutrition" is. His mistake lay in applying his definition to the wrong things.

As we now know, of course, the place where the first scientific dietitian went wrong is this: The working muscle does consume its own substance. About that, there is no question. *But it does not consume all parts of its substance equally.* We are built of flesh; but we run on sugar, precisely as the simpler engines of automobile and motor-boat are built of steel and run on gasoline. We continually use up and renew a substance of which the body at any single moment contains very little; so that like

any other explosion engine, we use up our weight of fuel many times over before we wear out our substance once.

With the proof of this simple fact departed once for all from scientific literature Liebig's rigid distinction between "fuel-foods" and "muscle-formers." All proper foods, as we now know, are built into the substance of the body, and are therefore "tissue-builders." All likewise, except water and various salts, yield heat or work indifferently, and are all alike, therefore, "fuel-foods" and "energy-producers." There is no sort of foodstuff which forms muscle, which does not equally form brain, nerves, skin, bones, hair, and finger nails. In the light of our present-day physiology, all these old phrases have about as much literal meaning as our saying that the sun sets.

A curious paradox follows from this modern scientific doctrine of animal nutrition. The body depends most for its nutriment on the very substances of which it contains least. Of all that we take into our mouths — we are supposed to breathe through our noses — the

most indispensable is water. It is the chief "tissue-builder," for it makes up three fifths of the total weight of the body, and the daily intake is three times that of all other foods combined. Yet this essential "muscle-maker" is not in the slightest degree nutritious. Not one stroke of work from cradle to grave does any man ever do on water.

Next to water as "tissue-builders" come the proteins, which build the living protoplasm, and without which there could be no body at all. Yet the precious vital substance wastes at the rate of only three or four ounces a day, and wastes equally slowly whether the body works or rests.

Third in order, unless one is over-fat, come the inorganic salts which form the skeleton. But the bones, once formed, are permanent, and their elements have no part at all in the day's labor.

Meanwhile the great ruck of the old "fuel-foods," principally of course the starches and sugars, which appear only in small quantity in the substance of the body, are the real nu-

trients which do nine tenths of the body's work. They are taken into the living tissue, exploded, thrown out again, and renewed almost as rapidly as the gasoline vapor in the cylinder of a motor-car.

"The evil which men do lives after them." Liebig was one of the leading scientific men of his time, and he had besides a popular following that went even beyond his reputation among his own kind. His laboratory at Giessen was almost the center of the chemical world, the best teaching institution outside Paris, and the Mecca of all the ardent young chemists of Christendom. The Baron himself was a most forceful and inspiring personality; while his famous "extract" was as much a household word to our parents as, let us say, Postum is to us. What wonder, then, that his peculiar views bit into the popular mind, and stuck there long after science had abandoned them.

As a matter of fact, every one of us, man in the street, cooking-school teacher, writer on domestic science, amateur adviser to the

public on the care of its health, has his practical ideas concerning diet more or less colored by this quite erroneous theory of Liebig's. It disappeared from all scientific works before 1880; but it still haunts the minds of Dietitians in Ordinary to the General Public and bobs up in the housekeeping magazines. Many a good dollar does it cost us every year to buy food that Baron von Liebig supposed to be nutritious instead of that which the United States Department of Agriculture knows to be.

III

WHAT ALL THE WORLD IS EATING

ONE of the curious things about human diet is that no matter what men have thought they believed, they have acted, always and everywhere, in pretty close accord with our modern scientific doctrine of food values. People have maintained all sorts of theories, have clung to all sorts of superstitions. They have held the cow sacred, abstained from pork, shunned horseflesh. They have eaten black bread and white; they have lived on rice and dates, and never eaten bread at all. There are whole races who never taste meat; and whole races who virtually never eat anything else. But one and all, *semper*, *ubique*, *omnibus*, they have pitched upon viands that would run a locomotive if dried out and burned under the boiler.

This done, it has not seemed to make the least difference what the foods are, provided

only that they are wholesome of their kind and suitably cooked. Our army fights on a daily ration containing a pound and a quarter of meat. The Roman legionaries, who also did some fighting in their day, lived on grain flavored with lard; while even amid the luxury of the Empire, the gladiators were still called *hordearii*, that is, "barley-eaters." On the race of the allied armies to Pekin, the Japanese soldiers fairly ran away from the European regiments — and on a diet of boiled rice and dried fish.

A Yale team trains on beef and mutton. The Greek athletes, who also were goodly men, trained on barley, figs, and olive oil. The flesh-eating American Indian has been called the original scarlet runner. But in the other India, in the old days before the telegraph, the messenger service from Madras to Bombay and Calcutta was by means of men on foot, who did sixty-odd miles for a day's work, and kept it up, a thousand miles at a stretch, on rice. Potatoes have been the main food of the Irish for two hundred years — and yet one

still sees an occasional Irish name in the sporting column.

So it goes. Three meals of meat a day, with beer, support the eight hours' strenuous toil of the plumber. The New England farmer, a generation ago, put in his sixteen hours a day in the hayfield on pie, baked beans, and doughnuts, rarely eating meat at all except when he killed a "critter." In China, where two acres of ground supports a family of five, and the diet is rice, sweet potatoes, beans, and garden stuff, a tea-carrying coolie for a day's work, packs a hundred and fifty pounds over forty miles of road. The famous porters of Asia Minor walk off with a quarter of a ton on their backs, and nothing but bread and dried fruit on their insides. The Chilian miners, whom Darwin judged the strongest laborers in the world, toil on boiled beans and bread.

Nor does the source of a people's food seem to make the smallest difference in its mental or moral qualities. Our own Plains Indian, who lived largely on meat, was fierce enough. The Mongol Tartar made his name the

synonym of all that is bloodthirsty and cruel.

> ". . . Who can stand his raging force,
> When first he rides, then eats his horse?"

The nomadic Huns were truly the "scourge of God." Yet the Eskimos, who also live entirely on meat and eat ten pounds at a meal, are the most peaceable of mankind, and do not so much as strike with their fists. But the Armenian massacres, the Balkan atrocities, the Russian pogroms, are the work of essential vegetarians.

Most of us believe that the flesh-eating nations are the leaders of civilization, and that plenty of meat is the only diet for efficiency. But the Abyssinians and the Turkomans, the New England Indians in colonial days, the Koreans, Tibetans, Hottentots, Papuans, Gypsies, Patagonians, Maoris, also enjoy a mixed diet with plenty of strong meat — and are neither civilized nor efficient. Who can say whether the roast beef of Old England or the bannocks and the halesome parritch of the

Scots has builded the better quality of brain?

It is all exactly as one would expect from a glance at the food of the lower animals. When mighty hunters tell tales of escapes with the skin of the teeth, it is a toss-up whether the charging beast will be a lion, a rhinoceros, a grizzly bear, an elephant, a wild boar, or a bull moose. Yet the lion subsists on flesh, the rhinoceros and elephant eat straw like an ox, the boar grubs for roots, the moose consumes leaves and twigs, and the bear eats anything he can get. They say that even the great cats keep away from the gorilla. The gorilla lives on fruit.

As for the harmless necessary cat, the faithful dog, the robin redbreast and most of the little song birds, the gentle seal, the garden toad, the clam, and the bath sponge, are they not all alike carnivores, who slay to eat? If food really counts as much as is often said, there ought to be more difference than there is between polar bear and grizzly, wasp and bee, fruit bat and vampire, or the two sides of

almost any such pair that one can manage to think up. The only obvious fact is that, save for an occasional dog, the only creatures strong enough to work are eaters of hay.

The food, then, is only the fuel; and any sort of creature may be built to eat anything. Efficient nations and strong men are nourished on any kind of wholesome food, decently cooked, if only there is enough of it. All the old staple foodstuffs, all the established national diets, are good. By the proof of the eating, they are equally good.

IV

CERTAIN PRIVATE VAGARIES OF DIET

ALL the queer people in Germany, all the vegetarians, fruitarians, and eaters of uncooked foods, all those who sleep out of doors or wear woolen all the year round, all the people, in short, who are trying to convert the world to any sort of private vagary, have their eyes fixed on the annual Whitsuntide walking-race from Dresden to Berlin. This, by custom, has become the try-out for every uncommon mode of life.

The test is by no means ill-chosen. To win, one must cover a hundred and twenty-five miles in about twenty-four hours, and well within forty hours to be placed at all. Several eminent physicians and men of science commonly attend each race; while the more promising contestants are often under observation for a week or two beforehand and a day or two after, so that the results of the test have

a scientific standing that is lacking in the ordinary athletic contest. Walking, moreover, is the least artificial of all games, the one sport that takes only a sound body and a stout heart.

The race of 1902 is especially famous. The winner was a corresponding clerk, thirty years of age, Karl Mann by name, who had been tied to his desk nine hours a day and had done most of his walking on Sundays. He had been a vegetarian for ten years, but latterly had gone in for raw foods; and for six months before the race had eschewed, not only fish, flesh, fowl, alcohol, tea, and coffee, but eggs, milk, cheese, and butter as well. His training diet was two meals a day of crackers, bread, marmalade, fruit juice, Quaker oats, nut butter, and bromose.

The next five of the thirty-odd contestants were also food cranks, mostly eaters of nuts; and only with the seventh man did the conventional diet make its appearance at the finish line, eight hours behind the winner. The result, other years, has been much the

same. The members of the Vegetarian Society have made it a point to win, "for the good cause."

The corresponding stunt of the British Isles is to walk from Land's End to John o' Groats, a distance of some nine hundred and eight miles. At latest accounts, the record for the feat was held by a young workman named Allen, who covered the distance in less than seventeen days, and did one hundred and forty miles in the last two. Allen is a man of somewhat radical opinions, who sleeps out of doors under a tree, and feeds on bread, oatmeal, and vegetables, with a little fruit.

To turn to our own country, there are the men nurses from the Battle Creek Sanitorium, all of whom are vegetarians, whom Professor Irving Fisher matched against his student athletes on the conventional training-table diet in one of the stock endurance tests, holding the arms extended horizontally at full length. The nurses came out distinctly ahead. The best of the college boys was a baseball player who held out his pitching arm for an

hour and fifty minutes, though few persons can last more than five. But several of the nurses went beyond the hour, while one stopped at three hours and twenty minutes more from boredom than fatigue.

Not to multiply cases unduly, Mr. Horace Fletcher, who begins his day's work at 4 A.M. and eats nothing until noon, when he was well past the half-century of life, put in a week with a Yale boat crew in training, and fairly held his own with the lads. Yet his diet was cereal, milk, and maple sugar, costing eleven cents a day. Mr. Eustace Miles, five times amateur tennis champion of England and the world's foremost amateur racquet player of his day, lives for the most part, in training and out, on protone biscuit, a peculiar milk product called plasmon, fruit, and hovis bread.

In other words, ever since the Reverend Sylvester Graham narrowly escaped being mobbed by the butchers, because he persuaded the public of his day to eat his bread in place of their meat, an increasing number

of men and women in all civilized lands, for reasons adequate to their minds, have been breaking away more or less completely from the food traditions of their kindred, to adopt the diets of unrelated peoples, or to consume newly invented viands such as never were on sea or land.

Virtually without exception, these dietetic heretics affirm that their departure from orthodoxy has been to their advantage both in health and efficiency. Doubtless they are right. Mills is an instructor at Cambridge. Chittenden and Fisher are at Yale. Kellogg is head of a great sanitorium. Fletcher is a successful business man who for long periods has been under observation by some of the foremost physiologists of America and Europe. That such men should be mistaken on so personal a matter is unthinkable.

It is, therefore, sheer superstition, and quite without any basis of fact, to say, as is often said, that while Hindu and Eskimo and Hottentot may manage to get on with this, that, and the other barbarous diet, we civilized

people must have to eat precisely what we have been having, and that the particular things that we happen to have been buying are, to quote a recent magazine article, "essential not only to our well-being but to life itself."

Speaking somewhat broadly, a man can live on any wholesome food, which he likes and can digest, and which has not too much water in it for him to get his day's fuel out of three or four pounds. From that, in a few weeks or months, he can change to any other like diet, and do equally well on it. Modern science and immemorial experience alike testify that what counts in a food is its "fuel value." The most that we ask of our diet is that it shall drive the engine.

Most of us have, however, certain idiosyncrasies. One person cannot eat mutton. Another is poisoned by strawberries. In like manner, but on a smaller scale, each of us has found, or has still to seek, some dietary which, on the whole, and while all things continue as they are, will suit him better than

any other. It may be five meals a day, or it may be one. It may be lean beef and water; or it may be grape juice and almonds. It may be the "American breakfast" or the "Continental." It may even be precisely the things that all the family and friends and neighbors have always eaten. For most of us, it probably is the latter, and the difference is commonly not great anyway.

No one has, then, any special call to argue with anybody else. Allen and Karl Mann outfoot the meat-eating walkers, Eustace Miles and Horace Fletcher accomplish their truly remarkable feats, not because walnuts or plasmon or bromose or lettuce leaves are peculiar foods, but because each of these men has found the special diet which, for the time being, happens to suit him. They feed their boilers with especial skill. Naturally, they get more work out of their engines than the men who dump in whatever comes along.

It is, therefore, not a question of this, that, or the other food; but of adjusting the food to the eater and the work. For this reason

Sir Ernest Shackelton, whatever he may eat at home, across the South Polar Ice Cap, guided by the best wisdom of science and experience, travels on nuts, lard, oats, olive oil, wheat protein, sugar, and dried milk.

V

THE MEASURE OF HUMAN WORK

WHEN once it was established that the animal body is a highly complicated engine running on its oxidized food, it became a very pretty little problem to determine just how much work each human machine is doing from hour to hour.

Early studies of this sort, during the eighteen sixties, were made largely by direct measurement of muscular lift. In the famous "Faulhorn experiment," for example, two young rebels against the authority of Liebig climbed a six-thousand-foot peak on a diet which, if the Baron were right, should not have been the least use to them. They lifted a known weight through a known distance; and simple multiplication showed more than twice as much "work" as the "elements of nutrition" theory could account for.

From these somewhat crude beginnings,

science has advanced to Atwater's great respiration calorimeter at Wesleyan University, a fair-sized stateroom, closed and copper-lined, with bed and chair and table and stationary bicycle and telephone, in which a man can live for a week, eating, sleeping, reading, working, exercising, with every breath of air and every mouthful of food and every degree of body temperature accounted for down to the half of one per cent, even to the growth of nails and hair.

But even without any elaborate apparatus, it is always possible to find the work being done at any moment simply by exhaling the breath through lime water. The carbonate thus thrown down measures the output of carbon dioxid, and this in turn measures the total combustion. This was Lavoisier's old method with which he made his studies on the guinea pig, in the early days of chemistry, shortly after the first discovery of oxygen. Of late years, it has been used to sift out the particular amount of work involved in most of the common acts of life.

It would be a simple matter to reckon the human body-work thus determined, in horse-power, as we rate our motor-cars, or in kilowatts, as we buy electric current for our vacuum cleaners, or in any one of a half-dozen other common units. Convenience and mere accident of custom has, however, brought it about that human labor and the food energy that makes it possible are both figured by the so-called "large calorie."

The dictionaries will enlighten the inquiring mind as to precisely what this unit is, and its relation to the watt, the horse-power, and the rest. Sufficient it is for our present purpose to note that one calorie per minute is not far from one tenth of a horse-power, and that the "large calorie" of physiological chemistry is one thousand times greater than the "small calorie" of physics with which it is wont to be confused.

It has turned out, as one might perhaps expect, that the productive outside labor that earns our daily bread is commonly very much less than half the day's work. We employ, to

begin with, some hundred and fifty or two hundred calories of energy to digest the food which makes any labor possible. The heart-beat is a steady load, and although throughout the summer the waste heat of our labor commonly keeps us quite warm enough, we are forced, in winter, to squander some hundreds of calories more merely to keep from shivering. Even nervous fidgetings, and the aimless tightening of muscles which might just as well be relaxed, amount to a measurable quantity of effort.

One thing with another, a 150 or 160-pound man, flat on his back in bed, will still do some 1850 calories of work in 24 hours. If he is up and about the house, or if he motors back and forth to his office and goes up and down in the elevator, his heart will have to pump his blood uphill, he will make many small movements, and it will not be quite so easy for him to keep warm. Altogether, it will cost him some 20 calories an hour more than if he had stayed in bed, or 1550 for the 16 hours that he keeps awake. Allowing 8 hours in bed as before,

2170 calories is the measure of this very light day's labor.

Most persons, however, do get some exercise. The result is that the general run of professional men, desk and office workers, watchmakers, tailors, typists, draughtsmen, and the like, who sit at their work, score, on the average, close to 2500 calories for the total day's labor.

Moderate bodily toil that keeps a man on his feet, but into which he does not have to put his back, — the railway service, let us say, or the work of a skilled mechanic, — means another 500 calories. Really hard work, like farming or mining, means about 3500. The logging gangs in the northern woods go beyond 4000; while one professional bicycle rider, confined in Atwater's calorimeter, and for a single day, pushing himself to the limit of his trained endurance, turned off 9000 measured units. It takes in the region of 500 an hour to play a football match.

Little people do less total work than big ones, but more pound for pound. A child may

do 1000; a boy of twelve, 1500. In general, a woman of 110 or 120 pounds, sitting at her work, or "playing lady," will accomplish some 1800 calories. The lighter parts of housekeeping will require 2000; full housekeeping with washing, scrubbing, and making beds, 2500. To nurse an infant of five months costs 600 calories a day.

It is a striking commentary on the accuracy of this modern work, and the soundness of our modern theory, that the inhabitants of Paris — housekeepers and workingmen and children together — take home from the markets every day an average of 2500 calories worth of food; while the actual dietaries of farmers, from places so distant and so different as New England, Italy, Finland, and Mexico, do not anywhere, on the average, depart by 20 calories a day from 3550.

The conditions of labor, however, affect decidedly the amount of "work." The trained man, hardened to his task, may actually do a quarter less for the same output than the duffer. Fatigue, on the other hand, may add a

quarter to the labor, as unemployed muscles attempt, aimlessly and inefficiently, to help out the weary members. An overheated body, also, labors inefficiently; and they have found in the German army that an ill-fitting shoe, that hurts a soldier's foot enough to make him limp only slightly, runs up the work of covering a mile to a fifth above the proper level. Oddly enough, the work of carrying a load in a knapsack on the shoulders is somewhat less than that of toting the same weight of fat under the skin. But an ill-fitting harness, that makes the load uncomfortable, runs up the work like an ill-fitting shoe. All of which facts, the result of painstaking scientific measurement, have no small bearing on the practical conduct of a working life.

Curiously, too, it transpires that labor performed below the natural speed of the laborer actually takes more calories of work to get it done than if taken briskly — and this up to as much as seven per cent of the total. This also has its practical bearing.

We have already noted that mere aimless

fidgeting is "work," and this, it turns out, may mount up to a tenth of the day's productive outlay. On the other hand, complete relaxation, such as is practiced in the cult of power through repose, cuts down the body-work a fifth below the level of ordinary rest in bed, and drops it slightly below that for sound sleep. A quiet worker, then, saves himself work.

By much the same device, the aged bank their fires down to some four fifths of their mid-life energy; and if they are let alone, eat to correspond. One thing with another, a particular man or woman may depart from the average by 250 calories a day.

Per contra, "brain work" is not work at all, in the scientific sense. The mental fag — which, by the way, some brain workers insist that they never feel — comes only from bad air, congestion of blood in the head, or the discomfort of sitting still. After all, the whole nervous system is only a thirtieth of the body, while the portion of it that has even a remote connection with our thinking is not a tenth

of this. So even if the thin shell of gray matter over our left ears really did do any "work," an hour's thinking could hardly involve so many calories of energy as one good yawn at the end. As a matter of fact, all precise measurements agree that a man swapping stories with his feet on his desk is doing, if anything, slightly more work than when he thinks his hardest. The concentration of mind keeps him quiet. So the brain worker on a vacation always does more "work" and needs more food than when he is making a living.

All of which is exactly what we should expect in the light of our modern doctrine of the relation of the soul to the body. None the less, emotion, with its physical signs, its bounding heart, its labored breath, is "work" — and far more tiring work oftentimes than it looks.

VI

THE LATENT ENERGY OF THE FOOD

IF one is to get through two thousand calories of work in a day, he must, in the long run, get two thousand calories of energy in his daily food. Practically, he will have to take in slightly more, for no man's digestion is quite perfect, and only a few viands ever develop quite their full indicated horse-power.

Rubner's standard, given as a table at the end of this volume, allows a margin of safety amounting to slightly more than one hundred calories between human nature's daily food as it actually comes to the plate and the energy to be extracted from it. An ill-chosen boarding-place, a wife who cannot cook, a bad set of habits, a zeal which is not in accordance with knowledge, may cost a hundred calories or two additional.

For us, then, who work with our heads and hands, rather than with our legs and backs,

2100 to 2700 calories of energy will have to be latent in the day's food.

Now, it so happens that the so-called fuel values of all known substances have long ago been measured, and all proved to be precisely the same whether the oxidizing be slow or rapid, inside the body or out. The most "nutritious" of all things is hydrogen gas, with a fuel value in the region of 16,000 calories to the pound. From this, the latent energies drop down by way of the pure fats at 4220 and hard coal at 3500, through alcohol at 3200 and sugar at 1860, to water at nothing at all. Between these two limits, all known bodies find their place.

Luckily, however, virtually all actual foodstuffs fall into one of three groups: Either like water and table salt, they have no fuel value at all; or else like all the various fats and oils, both vegetable and animal, they lie close to 4220 calories to the pound; or finally, like most other things that go into our mouths except salt, water, and the fats and oils, they develop so close to 1860 calories to the pound that this

number is commonly assumed as the fuel value of them all.

All actual foods, then, of which we commonly eat enough to count, belong to the zero class, the 1860 class, the 4220 class, or else are a mixture of two or more of these. In a rough way, one can always estimate the fuel value of any dish by leaving out the water and counting the fat twice.

Clearly, then, no watery viand can possibly be especially nutritious. Tea, coffee, beef extract, the unsweetened liquids of the soda fountain, have, at best, only one part in the hundred anything but plain water, and even this little is non-nutrient. On no number of barrels of these could anybody wink an eyelash. Beef tea and the various clear soups are some 97 per cent water. And since the remaining three per cent is partly salt and nearly fat free, the total nutriment in a pint of any one of them is of the general order of 50 calories. But a thick soup, pea, for example, or a clam chowder, being only 80 or 90 per cent water, may go as high as 250 calories to the pint. By the same token

"blue" milk is some 170 calories to the pound; but whole milk, by virtue of its cream, goes to 325; and cream, which is only three quarters water, to 1000. A breakfast food, made up one part from the package and four from the faucet is, of course, worth, at most, the fifth part of 1860, or say, 370. A surprisingly large number of common foods, in spite of appearances, are really of the thick-soup-and-breakfast-mush class.

All our gelatin desserts, all our fresh vegetables, all our fruits, all our lean meats, white fish, oysters, lobsters, eggs, even our potatoes, are three fourths, seven eighths, and nine tenths water, and therefore, at the best, cannot touch 1000 calories of food value to the pound.

Everything, in fact, that is eaten about as it was when alive, is bound to be mostly water, else it would not have been fluid enough to go on living. All such, then, can be only moderately nutritious. Their place in the diet is, in large measure, for other reason than their fuel value.

Foods, then, to which we add much water and foods to which some previous owner has added water for us, form together a fairly well-defined group with an energy value below 1000 calories to the pound.

But a plant that is three quarters water during the growing season, when it comes to salting down its gains for its seedlings, does it dry. All seeds, therefore, beans, peas, lentils, corn, wheat, oats, and the rest, are an eighth or a tenth water with only a trace of oil. They run, therefore, a little under the 1860 calories to the pound. So everything made from flour, from bread at 1200 calories to the pound to doughnuts at 2000, are in the same general class — a little low if they have overmuch water and a little high if they are rather "short." Only the nuts, which lay up more of their treasure in the form of oil, and the nut meals and nut butters made from them, run up into the three thousands.

In the same way, all sorts of fruits and vegetables out of which we and not the plants have taken most of the water, all the raisins,

currants, figs, dates, prunes, evaporated apples, and the like, run about like the grains; while most jellies and marmalades, by virtue of their abundant sugar, become a sort of artificial dried fruit.

The animals, however, unlike the plants, store all their provision for a rainy day as fat. And since oil and water, proverbially, do not mix, the fat is nearly enough dry to be worth 3500 to 4000 calories to the pound. The creature mixes it, a streak of fat and a streak of lean, in such proportion that the ordinary run of oily fishes and moderately fat meats and poultry break just about level with the grains and the dried fruits.

Starch and sugar therefore, without much water or oil, and muscle fiber with both water and fat, are the two great groups of staple foods, one animal, the other vegetable. Their energy value lies between 1000 and 2000 units to the pound.

Above this higher value lie, in general, only those foods which art and man's device have made oleaginous and dry. Most cheeses are

just above 2000. The extracted fats run above 3000. Only nuts and fat pork of Nature's handiwork in any way rival man's. Finally, we come to the pure fats like lard and olive oil, which, at 4220 calories to the pound, are the most nutritious substances which any living creature eats, or which can ever be discovered or devised.

In short, the lettuce leaves in a salad, at 85 units of work to the pound, and the oil on it, at 4000 odd, are about the extreme nutritive range of our ordinary foods, the one having more than forty times the latent energy of the other. As for the rest of the thousand and one things that we eat, are they not all written, in brief at the end of this volume, and at greater length in the Twenty-eighth Bulletin of the Experiment Stations of the United States Department of Agriculture, seventy-seven pages, price five cents!

VII

THE NORMAL RATION

A STARVING man, in good flesh to start with, kept warm, and doing light work, consumes his own tissue at the rate of fourteen and a half calories per day for each pound of body weight. This, then, on the face of it, is the irreducible minimum below which the daily intake of foodstuffs cannot go.

One burns his own flesh, however, somewhat less freely than the bodies of other creatures, and more economically, so that it takes some ten or fifteen per cent more of ordinary food than of body stuff already digested and stowed away. Sixteen to sixteen and a half calories of an ordinary mixed diet for each pound of body weight is, then, the practical limit for a fair-sized man at light work. Little people live at higher pressure up to twenty calories to the pound. Rubner's allowance, as tabulated at the end of this volume, gives for good

measure, seventeen calories for each of the hundred and fifty-four pounds, which for the sake of making it an even seventy kilograms is commonly assumed as the weight of a grown man. Unquestionably, however, many persons, — conspicuously, of course, the disciples of Mr. Horace Fletcher, — do succeed in conducting the department of the interior so efficiently as to get well under these figures, and close to the starvation level.

Two thousand calories, then, or a few hundreds over, is the daily requirement of most persons who will read this book. It is the work of a candle burning a half-pound of tallow a day, or of an alcohol lamp consuming eleven ounces of spirit. There is a like efficiency in a pound and a quarter of candy, or three and a half pounds of lean meat, or two dozen eggs, or nine doughnuts, or one peck of turnips, or twenty quarts of beef tea.

Actually, of course, we have to combine these and a thousand and one other foodstuffs into a workable ration that shall, on the whole, meet all the requirements of the body every

day, and at the same time be a succession of meals that a reasonable human being will like.

To start, then, with the initial repast of the day, the standard "Continental" breakfast figures out: —

Coffee, with cream and sugar, say	100 calories
2 rolls, 2 ounces each, at 76 calories to the ounce	304
½ ounce butter, at 228 calories	114
Total	518

Or, if one takes chocolate in place of coffee, making it with a half-ounce of chocolate (at 179 = 90), a half-pint of milk (at 320 = 160), and a half-ounce of sugar (at 117 = 58), there will be 308 calories in place of 100, and the entire breakfast adds up to 720 — by no means a "light" meal in spite of its simplicity.

A typical breakfast in a well-to-do American family might run: —

1 orange, grape-fruit, or the like	100 calories
5 ounces "breakfast food," with cream and sugar	100
2 eggs, 2 ounces each, at 45	180
1 slice of bread, 2 ounces, at 76	152
¼ ounce of butter at 228	57
1 large cup of coffee, with sugar and cream	100
Total	689

Naturally, one can only guess at the precise amounts of each dish which our hypothetical American business man would eat. Apparently, however, he gets no more real nutriment out of his somewhat elaborate three-course meal than Tartarin de Tarascon Sancho Pança out of his chocolate and rolls sitting up in bed.

As for Mark Twain's "simple breakfast" that began with "a mighty porter-house steak an inch and a half thick, . . . enriched with melting bits of butter . . . archipelagoed with mushrooms," and ending with buckwheat cakes and maple syrup, — or any other meal that anybody can weigh and eat, — it is merely a question of looking out the items in the table and adding them up.

Or, by way of variety, take the following actual meals of an actual family, camping, and eating various extraordinary combinations to save work for the cook — and incidentally making it easy for the dietitian. There were three adults and three children in the group, and their combined light-work ration accord-

ing to Rubner's standard for their body weights figures 9850 calories for the day, or 1640 apiece: —

First dinner

Bread, 1 pound, 9½ ounces	1937 calories
Butter, 2 ounces	450
Doughnuts, 6 ounces	750
Cheese, 3 ounces	366
Sugar, 3 ounces	348
Milk, 1 quart	650
Total	4501
Or for each person	750

The sugar and milk were for coffee, which is itself not worth counting.

Second dinner

Bread, 1 pound, 7 ounces	1747 calories
Asparagus, 1 pound, 4 ounces	250
served on the bread, toasted, with a sauce made of	
Flour, 2½ ounces	255
Butter, 2½ ounces	562
For dessert, strawberry short cake	
Strawberries, 1 pound, 2 ounces	200
Sponge cake, 1 pound	1795
Thin cream, ½ pint	600
Total	5409
For each person	901

Third dinner

Beef tongue, 1 pound	740 calories
Bread, 8 ounces	608
Spinach, 3 pounds, 13 ounces	421
Olive oil, eaten on the spinach, 2 ounces	527
Potatoes, 1 pound, 7 ounces	553
"creamed" with	
Butter, 1 ounce	225
Flour, 2 ounces	206
Milk (skimmed) 1 pint	170
For dessert —	
Cookies, 3 ounces	357
Coffee jelly, only the sugar reckoned, 6 ounces	696
Total	4603
For each person	767

If we allow this family only the Continental breakfast, with milk for the children instead of coffee, that meal will take care of, let us say, 550 calories. The mean of the three meals here figured is 825. This makes 1375 out of the theoretic 1640, with another meal still to come. Evidently, this particular household is in no danger of being underfed.

It is, then, a very simple matter for any single eater, armed with a letter scale and the ordinary tables, to reckon his daily intake with an accuracy quite sufficient for all prac-

tical purposes. A cook, keeping track of the raw materials that go into the meal, and subtracting out whatever remains uneaten, can with even greater ease compute the entire family ration. Even simpler, for many purposes, is it to figure the supplies for a week or a month as they come in, and from these determine the daily average. In like manner may be figured the fuel value of any standard portion or any special recipe.

Practically, however, outside an institution, it does not pay to do this very often. In the long run, the individual man or woman must eat by judgment and appetite. The real object of an occasional determination is to train the judgment and to measure the appetite against a fixed and impersonal standard.

If, then, one turns out to be eating too little, it is a simple matter to lean a little harder on the more nutritious viands, and so to cheat the appetite by increasing the total intake without augmenting the bulk. *Per contra*, if one is eating too much, he has but to let up on the nutritious things that he does not

especially care for, and to make it up with the innutritious things that he likes. If by any chance anybody should turn out to be right, he may follow his likings with a quiet mind.

VIII

A THOUSAND FOOD UNITS FOR A DIME

WATER is properly worth about five cents a ton. That is what we pay for it out of the faucet. Some of us, besides, for the sake of sundry teaspoonfuls of ether, alcohol, potassium tartrate, and tannic acid, to be had along with it, buy water by the nominal quart, and pay a dollar a pint. We buy water with our milk, at four cents a pound; and we buy it also with most of our solid foods at all prices from a cent or two a pound, up.

Now there is no reason known to science or to economics why anybody who can afford it should not pay any price he likes for his water, for the sake of what he gets along with it and cannot get dry. One does not begrudge the onion in his chowder even if it is eighty-seven per cent plain H_2O, nor the faintly nutritious soup that tunes up the digestive machinery for the meal that follows it. Only one

may do well to buy his water with his eyes open.

And as we can pay all kinds of a price for water, which is, after all, plain water and nothing else, so, too, can we pay all kinds of a price for the fundamental nutrients of our food. The beef fat that comes with a porter-house steak is precisely the same thing that we buy as suet — though the price is not. Fish oil is fish oil, whether in salmon out of season, or mackerel in. Lean muscle is just lean muscle, whether in terrapin, scallop, lobster, quail, brook trout, haddock, or beef shin. Hothouse grapes and dried prunes, cabbage and asparagus, fruit cake and common crackers, all reach the blood-stream in the same form, and the working muscle treats them all alike. The difference in the cost is altogether in the accidents; and in general, the more any foodstuff brings in the market, the less is it really worth.

Whoso, then, has a champagne-and-lobster income, let him eat, drink, and be merry until he finds something more worth while. Whoso has not, let him not think to waste away for

lack — not while there are beer and crackers. The beer will do him just as little good; the crackers are good for five times as much achievement. To say that living is expensive is merely to say that one's wife cannot cook.

Common impression is that vegetable products are much lower-priced than animal. This is by no means the fact. Cottolene and crisco are not cheaper than tallow and lard. Good olive oil is quite as dear as good butter. Green peas, out of season, fairly rival the salmon that goes with them. Mushrooms at a dollar a pound, each pound good for only two hundred calories of work, and precious little even of that ever extracted by the human digestive machinery, is probably the high-water mark of a useless food. In spite of wicked meat trusts, the cheaper animal fats are still among the least expensive sources of human energy.

The special economy of a vegetable diet comes in a few great staples. Potatoes at a dollar a bushel make the thousand food units cost about six cents. Corn meal at four cents

a pound drops the price below three. Flour at five or six dollars a barrel breaks just about even with corn meal. All the staple grains, in short, that go to make the staff of life in any form, give a moderate day's work for a nickel.

One could, then, even in these days of high prices, live on a dollar a week. Flour for bread and cheap meat, glucose and cane sugar, oleomargarine and peanut butter, lard, salt pork, and beef suet, dried peas, beans and lentils, oatmeal, prunes, sugar, are all to be bought in any city at any time for five cents a thousand food units; some of them, at some times, for as little as two.

With half the day's intake below five cents a thousand calories, the other half can go up toward ten and still keep the total cost within the dollar a week. All moderately fat cuts of all kinds of meats yield a thousand food units for a dime at all prices up to fifteen cents a pound, excluding bone and other refuse. Most nuts, bought shell and all, do the same. So, in general, do all dried fruits.

For uncommonly fat meat — pork chops,

ham, most bacon, sausages, much corned beef — and also for most sorts of cheese, one can pay up to twenty cents a pound and still be within the stint. The limiting price for butter is thirty-six cents a pound; for olive oil, eighty-five cents a quart; for potatoes, one dollar and sixty-five cents a bushel; for apples, big ones, a cent apiece.

In other words, the necessities of life cost five cents a thousand calories or less; the comforts of life lie within ten; and only the luxuries rise to fifteen and twenty.

Among these luxuries are lean chuck steak at any price over five cents a pound, shin bone at anything over three, beef liver anywhere above six. To yield a thousand food units for a dime, pigs' feet ought to bring less than four cents a pound, salt codfish about three cents, fresh haddock about a cent and a half. Eggs are a luxury above ten cents a dozen, milk above six and a half cents a quart. Only the rich and the improvident can afford to pay more than about a cent and a half a pound for carrots, turnips, cabbages, and squash. If beer

is "liquid bread," it is very liquid, indeed, for it takes a strong half-gallon of it to match the nutriment in a five-cent loaf.

Rich or poor, nevertheless, we can always afford to pay twice as much for shad and mackerel as for haddock and hake, and four times as much for salmon. Fowl is actually worth twice the price of spring chicken, though we do not have to pay it; turkey is equally cheap at three times the cost, goose at five times. Almonds match walnuts two for one. We get seven times as much for our money in the yolk of an egg as in the white.

All this presupposes somebody who can cook, and somebody to wash up the dishes afterwards. Ready-to-eat foods, a thousand calories for a dime, are rarer birds. Bread and butter will do the trick, or crackers and cheese, or either one with milk. For years — no doubt they do it now — the Massachusetts General Hospital had a lunch for the throng of outpatients waiting at its clinics and for the nurses and doctors on duty, two pilot crackers, two ounces of cheese, and a glass of milk, for five

cents. The crackers made 400 calories, the cheese 300, the milk 100; 800 for the whole. In small quantities it should have cost seven cents, which is just inside the limit.

Virtually any kind of cracker, any kind of cake, any kind of cookie, any sort of candy, eaten out of a paper bag is a safe shot up to fifteen cents a pound, while several different sorts are good buying up to twenty. Shredded wheat "clothes-brushes," and all the host of breakfast foods that are eaten as they come from the package, cost just about a cent an ounce and are worth just about a hundred calories a cent's worth. Doughnuts can commonly be bought to yield a thousand energy units for five cents. Dates, figs, and raisins, marmalade and various jellies become luxuries only when they cost more than fifteen cents a pound.

If, however, in addition to paying for the raw foodstuffs and their cooking, the eater is to add the cost of service, and any sort of clean and decent surroundings, he cannot possibly keep his operating cost down to anything like

ten cents a thousand calories. At good, low-priced restaurants, for example, the standard five-cent cut of apple pie yields only about three hundred calories; while even a fifteen-cent plate of pork and beans, with bread and butter thrown in, is well under the thousand. Ham sandwiches, corned-beef hash, beef stew, and the like, yield a thousand calories for about thirty cents. A club sandwich at a quarter does it for sixty. A lettuce and tomato salad, costing twenty cents, makes the thousand calories cost $3.85. No wonder the young people are being driven into matrimony!

But we need not pile up detail. Whoever, whether housekeeper or "mealer," is interested to distinguish the substance of food from the shadow, has only to take up any ordinary table of food values, and in the columns giving the energy content, to imagine the decimal point shifted two places to the right. The figures will then read the number of cents per pound at which each foodstuff will provide a thousand units of nutrition for one dime. Smoked herring, for instance, is rated at 1350

calories to the pound. At 13½ cents a pound, therefore, it gives its thousand calories for a dime. Sirloin steak, 1130, does the same when bought for $11\frac{3}{10}$ cents a pound — if it ever is. At $22\frac{6}{10}$ cents a pound, the thousand food units of sirloin steak would cost twenty cents. Thirty-four cents a pound is thirty cents a thousand calories. Granulated sugar lists 1860. It remains, therefore, an economical food up to $18\frac{2}{3}$ cents a pound. At $9\frac{1}{3}$ cents, it would give a thousand calories for five cents. At actual market prices, it commonly furnishes its thousand calories for less than three.

IX

THE FATS AND OILS IN THE BODY

ALL fuels are closely related. Coal and peat are only preserved wood. Wood, in turn, — a nutrient for various other animals though we lack the machinery to digest it, — is almost the same thing, chemically, as starch and sugar. But sugar is chemically an alcohol; and the simple processes of fermentation with yeast alters it into the ordinary ethyl alcohol — by no means an uncommon fuel both outside the body and in. Ethyl alcohol, however, is only the hydroxid of the second member of a series of hydrocarbons, which we know in common life as natural gas, gasoline, benzine, and naphtha, at one end of the line, up, by way of kerosene, to vaseline, axle grease, and paraffin candles at the other. Even ether, acetylene, and chloroform are cousins of this family of inflammables.

Parallel with the paraffin series runs a series

of fatty acids. The lowest member, corresponding to marsh gas and wood alcohol, is the acid of vinegar, into which another simple fermentation changes the alcohol of cider and wine. Higher in the line, at the level of kerosene and vaseline, come the acids whose sodium salts are the better sort of hard soaps, and whose glyceryl salts are the ordinary fats.

In brief, wood alcohol, natural gas, and acetic acid have for their radical CH_3. Grain alcohol is C_2H_5OH. The fruit acids are built around C_2H_5 and C_3H_7. The sugars are complex alcohols with either a C_6 or a C_{12}. Starch and wood fiber are a more elaborated sugar. Coal is compressed wood partly resolved back into natural gas and rock oil. The fats are the C_3H_5 esters of the acids of $C_{15}H_{31}$ and $C_{17}H_{35}$, with sundry other numbers thrown in, down to the eight per cent of the C_3H_7 fat in butter.

In other words, this small group of first and second cousins among chemical substances furnishes virtually all the power that drives all the machinery of the world and does all its work, except that which is done by windmills

and water power. Ocean greyhound and puppy, locomotive and engineer, are machines which burn about the same sort of fuel.

They used to tell us in earlier days of physiology that the digestion of the fats and oils involves only a division into fine particles to form an emulsion after the pattern of cod liver oil and cream. Unfortunately, this simple account has turned out not to correspond with the facts. A ferment or "enzyme," lipase, splits the fats into the glyceryl and the fatty acids. The glyceryl takes on the elements of water and becomes common glycerine. The fatty acids may sometimes even hitch up with the sodium carbonate of the blood to make an ordinary soap.

The glycerine and the cousins of vinegar acid, being soluble, pass through the walls of the digestive tube; and then, once more reunited, appear as the fat of the blood. Apparently, the same splitting into acid and glycerine enables the fat of the blood to pass into the various tissues.

If the tissue that absorbs the fat is working

muscle, this promptly burns it up for another stroke of work. Other tissues, which are not working, may simply fill up with fat, until the living protoplasm of the cells is no more than a thin film over a great drop of oil. A membrane as thin as a sheet of paper may thicken to an inch through. Then our waists depart, and the place thereof knoweth them no more; or some vital organ undergoes fatty degeneration, and the probate court takes charge of our mortal remains.

One of the curious things about fat is that the living body is able to make it out of any sort of foodstuff. "The friendly cow, all red and white," that furnished cream for R. L. S.'s apple tart, used grass as a raw material. The grass in its turn, when it went to seed and wanted to lay down food for its own offspring, made its fat — very little, to be sure — out of soil and air. So also, of course, do the various grains; more conspicuously the olive; and most conspicuously of all, the nuts, which are the hereditary plutocracy of the vegetable world, laying up treasure for their seedlings

in the form of oils up to half and two thirds their total weight.

The arrangement is distinctly well planned. Fat being more than twice as nutritious, weight for weight, than any other foodstuff, it is the one obvious form in which to store large amounts of energy in small bulk. A starving creature, living on its muscle, wastes away eleven and one half times as rapidly as when living on its fat. Professional fasters, in good flesh at the beginning, go thirty, forty, and even fifty days without food, ninety-eight days being the record for a dog. In fact, for a man resting or at light work, a mere half-pound of body fat a day is sufficient to keep the machine running. Such a concentrated nutriment, manufactured out of any sort of foodstuff that happens to be on hand, is an ideal device for storing up superabundant viands against a rainy day, and all the higher animals from the fishes up, have adopted the idea. But the plants, which do not move about, and therefore have no such need to save weight, use starch for their storage material, except occasionally in their seeds

and fruits. Flour and potatoes are, therefore, starchy, while meat and eggs are fat.

There is, then, no such thing as a "fattening food." We keep on hand about one day's supply of nutritive cash, holding it ready for use in liver, blood, or muscle. All else, over and above our daily needs, no matter what its source, we convert into fat, and salt down under the skin and in all the out-of-the-way corners of the body; and after these are filled, in places that are neither out-of-the-way nor corners. Any food is, therefore, "fattening" just in proportion as it is nutritious. The reputation of bread, potatoes, and the like rests simply on the fact that, since they have no marked flavor, we eat more of them than we realize. Candy and other sweets, we simply add to a diet already ample. Beer, though we think of it only as a drink, carries, nevertheless, some five hundred food units to the quart.

On the other hand, fat seems never, under normal conditions, to be altered into anything else. The fat of each meal passes into the blood. Part or all of it is promptly taken up by the

muscles and consumed. The rest, when there is any remainder, goes into storage. Whenever there is a call on the reserves — and this may happen toward the end of even a single day of uncommonly hard work — the fat returns to the blood-stream, and the working muscle takes it up as if it were fresh from a meal.

Unfortunately, in certain ways, the fats are not all alike. A hard fat like mutton tallow is largely the ester of $C_{17}H_{35}$, while the softer fat of beef runs more to $C_{15}H_{31}$, and butter, with its touch of C_3H_7, proverbially melts in the mouth. Olive oil, with its humble brother of the cotton seed, is built on a member of a closely related series, and has for its radical $C_{17}H_{33}$. This same oleine serves also to soften butter and lard.

Each creature, then, whether animal or plant, compounds its own characteristic sort of fat by mixing various related bodies. But a dog, kept hungry and then given unlimited mutton, will form dog fat in its liver, while it lays down sheep fat under its skin.

Now the digestibility of any one of these

mixtures depends on its melting point. Olive oil and butter are most easily handled. Pork fat and beef suet are partly melted in the stomach. Mutton fat is distinctly resistant; while only a lumberman in the winter woods or an Eskimo wonted to yard-long strips of whale blubber, has any real appetite for pure stearin, or can get much of any nutriment out of it.

Therefore, all slender, growing children and overworked, nervous, or anæmic adults, who most of all need a nutritious diet, should look to the soft fats and avoid the hard. Olive oil, cream, and butter, the yolks of eggs, nuts, cod liver oil, are often relished by digestions that turn handsprings at the thought of fried sausages. Furthermore, since part of the trouble from all fats is from the fatty acids split off during the digestion, there is an obvious profit in taking our fats without splitting off any more fatty acid by bad cooking — to say nothing of the anything but appetizing smell. Half the battle for the undernourished, then, is in uncooked fats with a low melting point.

The other half, since the total quantity of fat in any single meal is strictly limited, is in keeping the fat intake of each at the optimum amount, just short of the point where the generous diet begins to affect the appetite.

The most nutritious of the foodstuffs is the hardest to digest in quantity, and the most difficult to manage wisely in the daily food.

X

THE STARCH–SUGAR GROUP

THE starches and gums, the fiber of wood, and the various sugars, form together a very well-defined chemical group, the so-called carbohydrates. Like the fats, they all contain carbon; but unlike the fats, their oxygen and hydrogen are always in the same proportion as in water. They differ only slightly from one another, and they change back and forth on the smallest provocation.

Starch, wood fiber, and dextrin are all alike $C_6H_{10}O_5$. A trifle more of the elements of water makes $C_{12}H_{22}O_{11}$, which is ordinary cane sugar, malt sugar, and sugar of milk. A further "hydrolosis" makes $C_6H_{12}O_6$, which is common grape sugar, equally common fruit sugar, and one or two other sugars that are not so familiar. Mere heating alters starch to dextrin, as when bread is toasted or a polish put on a starched collar with a hot iron. Fruits ripen

from starch to sugar in the sun. Strong acids make even cordwood turn sweet.

Like changes occur with even greater ease in the body. The cow digests green wood. We, on the other hand, have to begin with starch, and to help along even that by cooking — the longer the better. In the end, cooking and digestion together, the starches and gums become sugars, and the double sugars, the 12-22-11's, become the single sugars, the 6-12-6's. Three fifths of all the food we eat finally reaches the blood as "dextrose," or as one of two other sugars virtually identical with it.

Now, dextrose is merely another name for grape sugar; and they both are the same thing as the ordinary "glucose," which is made here in the United States, thousands of tons a year, from corn starch, and used to replace cane sugar in sirup and candy. It is also one of the sugars of natural honey and of many sweet fruits besides the grape. Its twin, levulose, is the other sugar of fruits. Glucose is, to be sure, only a little more than half as sweet as cane sugar; but it makes it up by being cheaper

and by being distinctly less upsetting to the human stomach. It is besides about the only foodstuff, except alcohol, that does not have to be digested. Altogether, since dextrose is what our tissues actually use, the common prejudice against buying it frankly by the pound seems just a bit irrational.

Almost any other foodstuff, moreover, except fat, and including even lean meat, is likely to bring up in the blood, sooner or later, as this same corn sirup; while in starvation even the muscles themselves are sugared off and used to run the engine. Dextrose, in short, with some levulose and gelactose, which are virtually the same thing, is the one main working food of the actual tissues.

Oddly enough, however, although sugar is the chief nutrient of the muscles, the blood, at any one instant, contains very little indeed of it, less than two ordinary lumps in the whole gallon and a half. The amount, moreover, remains virtually constant no matter what we eat or how much we tire ourselves with work. When the quantity of sugar in the blood drops

below one lump, the body makes more out of whatever else it can. When the amount rises beyond two lumps, the excess is drained off by way of the kidneys and thrown away. Even a pound of candy, eaten straight off, will hardly alter the proportion of sugar in the vital stream.

The fact is, the sugar from a digested meal does not enter the general circulation. Instead, it goes directly to the liver, and is there undigested again into starch. This animal starch or glycogen is stored in the liver, up to something less than half a pound, and then, being slowly changed once more into sugar, is fed out to the blood-stream as fast as the muscles burn it up. The muscles, in their turn, pick up the sugar from the blood, undigest it once more, and hold it as glycogen until they start work. Then once again, apparently, the glycogen changes back to sugar, mixes with oxygen, and explodes.

Liver and muscles together can carry something less than a pound of animal starch, good for some sixteen hundred calories of work. Any

excess of food over this amount, that is not promptly used up in labor or thrown away, has to be stored as fat. Since twenty pounds of fat are the equivalent of forty-five pounds of glycogen, some of us may well thank our stars that the permanent storage takes the more concentrated form.

The sugar in muscle and blood, then, to adopt a figure from the world of finance, is the silver change and the small bills which we carry ready at hand to pay our way through the actual day's business. The glycogen of liver and muscle is the roll of big bills which we tuck away in stocking or inner pocket to break into as the small stuff runs short. The body fat is our bank balance, which we build up day by day as more cash comes in than we need to spend, and draw on in turn when income slackens or expenses run high. To carry out the figure, as we often pay a part of our bills by check, without changing the bank deposit into actual cash, so we do not, at least in health, make over the body fat into sugar, but consume it directly as it stands.

But whether our muscles happen to be using sugar or fat, it all comes to the same thing in the end. Both burn clean, the carbon to carbon dioxid and the hydrogen to water. The former goes off by way of the lungs, the latter is simply added to the blood as if it had been drunk from a glass. Neither puts any load on the organs of excretion.

Sugar has, nevertheless, one remarkable difference from most of the other substances that get into the blood. Being an alcohol, it is, naturally, poisonous, so poisonous in fact that but for our elaborate device for keeping the sugar content of the blood below the fifth of one per cent, all the bread-eating races of mankind would long ago have perished from off the earth.

In the too-familiar disease, diabetes, some failure of the pancreas limits or destroys the ability of the muscles to burn sugar. The liver can store only a small amount. The conversion into fat is a slow process. The result is that the sugar in the blood rises beyond the limit of safety, and the unfortunate victim, according to the severity of the attack, is

stupid after meals, or falls into coma and dies. Treatment is by increasing the fat in the diet and cutting down every sort of food that becomes sugar. With this precaution, patients may live out their lives in health. But more than one man in such a case has kicked over the traces, eaten one meal of bread and potato, and paid for the indulgence with his life.

From this point of view the old question, Is alcohol a food or a poison? becomes pretty meaningless. Most foods are more or less poisonous. Common alcohol, being worth some thirty-five hundred calories to the pound, is about twice as nutritious a food as bread or meat. It is not by any means twice as poisonous. The essential difference is that, in the course of some millions of years, the animal body has evolved a highly efficient apparatus for holding down automatically the diglucosic alcohol in the blood to fifteen parts in ten thousand. Therefore we handle, with every meal, ten times the toxic dose. But we have never, alas, evolved any such means of taking care of the alcohol of whiskey and champagne.

XI

OUR HUMAN LIFE-STUFF

WHEN all is said, the sugars and starches and fats and oils are only the fuel that drives the human engine — the machine itself is something quite different from them all.

Of its infinite complexity, this is not the place to speak. A single cell from the cortex of the brain, hardly in length from end to end the thickness of a sheet of paper, has an outline like a winter tree against the sky. A fleck of growing skin, far too small to be seen with the unaided eye, shows under the microscope more different and visible parts than any watch. Heaven knows what there may be in either too small to see. It is not too much to say that one human body contains more different structures, that have been drawn and named, than any city contains separate objects made with hands, even down to the pins and nails.

Here, however, we are concerned less with

the structure of the human machine than with the stuff out of which it is made.

"All flesh is not the same flesh; for there is one kind of flesh of men, another flesh of beasts, another of fishes, and another of birds." Furthermore, within the body of the same man, there is also one kind of flesh of muscles, and another kind of flesh of nerves, and still other kinds of flesh of every organ and tissue down to the three or four different sorts of white corpuscles of the blood and the seven distinguishable and separately named layers in the skin of the palm. All these are different, not merely in the sense that a chair is different from a bureau, both being built of wood; but different in the sense that an iron ship is different from a brick house, and corrosive sublimate, despite appearances, is not the same thing as common salt. The obvious physical difference between bone and muscle is matched by an equal difference of chemical nature. Even different parts of the same microscopic living cell are chemically unlike.

Living tissue is, then, an enormously com-

plex chemical machine, with more different forms of matter in it than any drug store, all combining and separating and changing into one another, back and forth incessantly so long as life continues, and then undergoing yet other transformations the moment life departs. So comparatively simple and stable a substance as ordinary grape sugar, left standing in slightly alkaline water, develops spontaneously some two hundred known and different chemical individuals — and the blood always contains grape sugar and is slightly alkaline. Nobody knows what happens when this same sugar makes itself over into fat.

The substratum of all this chemical kaleidoscope is, of course, the living protoplasm, "the physical basis of life." This protoplasm, in turn, while it may make or contain or excrete almost anything, is always, to begin with, some four fifths or more water; and for the rest, largely a mixture of various members of a somewhat ill-defined chemical group, the so-called proteins.

These, as one might expect from their rela-

tion to the great mystery, are the most complex of all known bodies, and among the least understood. If dextrose, which is merely $C_6H_{12}O_6$, can take on sixteen different forms and change to two hundred other things when treated with alkalies alone, one can imagine the possibilities of $C_{720}H_{1134}N_{218}S_5O_{248}$, which is a common protein of the body, or of $C_{758}H_{1203}N_{195}FeS_3O_{228}$, which is the red coloring matter of the blood.

Many of these proteins are more or less characteristic of certain tissues. Most creatures like ourselves have gelatin in their bones; and myosinogen in their muscles, which alters to myosin when the living thing changes to fresh meat. We feed our young on various milk proteins, the chief of which becomes casein when we make cheese. Our blood contains two or three albumins and globulins, besides the red coloring matter, the hæmoglobin, which we use to carry the oxygen to the tissues, some dozen or so in all. But other, lower creatures have a different outfit, and use a copper protein in place of our iron one to

breathe with. Keratin gives the horny quality to hair and nails and hoofs and claws. Fibroin and sericin account for the properties of silk.

Strictly, then, there is no "protein," but a vast array of separate proteins, each with its own properties and its own place. Among them, they construct the infinite detail of the animal machine. The proteins, in other words, are the bricks and beams, the stones and cement, out of which we build our house of life. As cottage and cathedral may both have windows of the same glass, as bricks out of the same kiln, blocks out of the same quarry, may be built into the walls of hovel or of palace, so a like albumin may be a part of hen's egg or human muscle, the same milk casein may nourish calf or child, the same keratin form the bird's feather and the cat's claw. Pyramid and office building, temple and shack, differ from one another in floor plan and style of architecture; but they are all constructed of stone, iron, brick, and wood. After the same fashion, pond scum and oak tree and man have

alike for their main structural material water and the various proteins.

The one obvious difference is that while the bricks stay bricks and the stones remain stones for, it may be, ages, the living substance of the human body is continually altering itself over into something else, as if the attic stairs of the suburban dwelling should suddenly become the parlor carpet, and the heating plant arise from the cellar and transform itself into a shelf of books.

XII

THE PROTEINS IN THE BODY

THE plants make their proteins, as they make their starches and oils, of the materials of soil and air. We animals cannot do this. We can change starch to sugar, and sugar to fat; and we can use fat in place of glycogen. But there our power stops. We cannot make any of the proteins out of other foodstuffs, and the only way for us to get them at all is to take them away from whatever other creature happens to be using them. Moreover, barring milk alone, we never get hold of any animal protein except by murdering a former owner.

Once having "lifted" the protein supply of any plant or animal, the first thing we do is to take it apart, first to protoses, then to peptones, as most of us were taught in school. Then finally, as only the youngest of us have been taught, since the fact is new, as the end-

product of digestion, we split up the original complex protein into sundry amino-acids.

Some fifteen or twenty of these are known, and together they account for more than half the protein molecule. There remains, however, a quarter or a third, of certain among even the commonest proteins which up to the present time has not been accounted for.

With the amino-acids, so far as they go, we are on known ground. They are about the order of complexity as the sugars, $C_3H_5NO_2$ being the empirical formula of one of the simplest — a long drop evidently from the original protein. For practical purposes, we may consider them as something not unlike a fat or a sugar to which has been added the so-called amine radical, NH_2.

On this amine radical hangs the whole story of the proteins both in the body and the diet. The fact that the other main foodstuffs do not contain NH_2, nor any nitrogen out of which it can be formed, is the sole reason why man cannot live by starch alone, but must seize upon the living substance of some other creature.

The various proteins, then, are split down into their amino-acids, and these in turn, being soluble, are absorbed into the system. Here they undergo two quite different fates. To begin with, all of us creatures who eat one another, virtually always take in vastly more amino-products than we can possibly use, even up to ten and twenty times. Promptly, therefore, sometimes in the liver, often in the intestinal wall before the amino-acid has fairly entered the circulation at all, the amine group, the NH_2, is split off from the rest, and thrown away as urea. The "deaminized" remainder becomes dextrose; and as dextrose goes through precisely the same course as if it had been made from starch to begin with. In other words, urea turns out not to be, as our school physiologies used to tell us, the nitrogenous waste of the tissues. It is rather the nitrogenous waste of the food, the remains of superfluous meat and eggs that are changed into sugar before they are allowed to enter the circulation. The nitrogen of the tissue waste appears largely as creatinin.

One hundred ounces of protein yield fifty-seven ounces of dextrose, and about all the real work we get out of that protein is what we get from the slightly more than half as much sugar which we make from it. The remainder, which contains the amine radical, gives rise to various harmful products, among them to uric acid, which is the probable cause of gout and of some forms of rheumatism. At best, the waste has to be disposed of at considerable cost.

Furthermore, the splitting-off of the amine radical from the dextrose — to put the matter somewhat too briefly — sets free a considerable amount of energy. For the most part, this energy cannot be taken up in useful work, because the splitting takes place neither where nor when there is work to do. It can then yield only heat. This heat may be most convenient in January — it is commonly most inconvenient in July. But whether the body wants it or not, it has to be made for the sake of cutting out that NH_2. Moreover, several of the amino-acids, notably, glycocoll, are specific stimulants to the heat-making apparatus.

There are, then, two good reasons for the traditional heating quality of meat in warm weather, when almost a third of the latent energy of the proteins must needs become temperature.

In other words, the Eskimo who takes five pounds of meat at a meal may send no more protein to his muscles than the Hindu who takes only five ounces with his rice. All that the tissues of either know is that the blood-stream brings them dextrose. But whether that dextrose was hydrolized out of starch, or ripened in grapes, or made by deaminizing the flesh of a stranded whale is quite beyond their concern. In a very real sense, therefore, protein is the one foodstuff which, in quantity, does not "build tissue," but does furnish heat.

The purpose of all this waste lies in the small portion of the protein end-products that do not become deaminized. Each several protein contains ten or fifteen different amino-acids, and each gets its peculiar quality from the amount and character of these, as all the words of the dictionary are built of the twenty-six letters of the alphabet. Our blood pro-

teins, for example, are largely leucin, with a good deal of glutamic acid, and smaller amounts of eight others. The two main proteins of wheat, on the other hand, are largely glutamic acid, with smaller amounts of fifteen other things and only a very moderate quantity of leucin.

Suppose now a meal of bread, split down to its amino-acids, absorbed into the blood and ready to be built again into the blood proteins. It will take three times as much of the bread proteins as are to appear in the blood in order to give enough leucin to make blood at all. But in that case, something like nine tenths of the glutamic acid will be useless, while for neither of two other amino-bodies will there be any place whatever. Roughly, perhaps a fifth part of the bread proteins will make blood. Some of the remainder will become other body proteins. The rest will have to be deaminized, and only their sugar be used. Nevertheless, it is by no means clear that a few of the simpler amino-acids are not sometimes made by breaking up the more complex.

It has long been known, sometimes by bitter experience in poorhouses and elsewhere, that men can be fed on gelatin in place of meat up to about two thirds the necessary intake. Beyond that point, the appetite fails, the gelatin becomes repugnant no matter how hungry the subject of the experiment may be, and in the end, the victim starves.

Now it turns out that gelatin, though apparently containing all the nutrients of lean meat, lacks completely three amino-acids which occur, in small amounts, in the chief proteins of human blood and muscle. The meat is cut down with impunity until the cystin, tyrosin, and tryptophan begin to run short. Then the trouble begins.

The same is true of zein, one of the main proteins of corn, the gliadin of wheat and rye, and the hordein of barley — except that no cook ever separates these proteins and serves them apart from the other proteins of grain, as gelatin is separated from the other proteins of flesh. All these want tryptophan. None can alone build the more important proteins of the

body. On none alone, therefore, can life be maintained.

The casein of cheese, on the other hand, is a nearly perfect protein, with fifteen out of a possible sixteen of the chief amino-acids, a chance to make the other, and all in a good deal the same proportion as in human blood and muscle. Glutenin, one of the other chief proteins of the grains, makes also a perfect score. Any of these alone will sustain life.

Contrary, therefore, to what is often assumed, the various proteins are very far from being all alike. Those of meat, fish, eggs, milk, and cheese are virtually on a level. Any of them will provide the entire outfit of amino-acids with little waste. But it takes a tenth more of the proteins of rice, and a quarter more of those of potato to make our body substance; while we can actually use only half the NH_2 of beans, eaten alone, less than half that of bread, and only three parts in ten of those of Indian corn. But beans and wheat combined supplement one another and approach perfection.

In brief, then, a certain portion of the pro-

teins of the food, after being split down into their amino-products, are built up again into the somewhat different proteins of human tissue. Some twelve hundred calories worth of these are kept on tap in the blood, ready to be redigested locally by muscle and gland and nerve, and to become their living protoplasm. Since, however, the proteins of the blood are not quite the same as those of the various tissues, there is another shrinkage here, with more NH_2 to go to the scrap heap.

Altogether, it is not an especially efficient arrangement. We have to eat, and dispose of, many times the amount of protein which we really want for our life-stuff, in order not to run short of any single amino-body.

Moreover, we have no way of storing the excess against a rainy day. Unless we are growing, or are building new tissue after starvation or a wasting illness, or are nourishing a new life, we simply live from hand to mouth, spending as we go.

XIII

THE PROTEINS IN THE FOOD

THE proteins put the eating classes between the devil and the deep sea. If we eat too little, we starve — starve just as surely, though not quite so soon, in the midst of other sorts of plenty, as if we had no food at all. The living protoplasm wastes slowly away by the mere act of living always at the same rate whether we work or sleep, and only the amino-bodies split from the proteins can make good the loss.

On the other hand, the proteins are the most expensive of foodstuffs to buy in the market, and the most expensive to care for in the body. Instead of burning clean to carbon dioxid and water like the sugars and fats, and going off peaceably through the lungs, the amine radical drops down through a score of different compounds, none of them wholesome and many of them poisonous. When the pro-

tein digestion misses fire, we get auto-intoxication and that tired feeling. When the protein elimination goes wrong, we get more auto-intoxication, rheumatism, gout, hardened arteries, premature old age. Even at the best we risk ptomain poisoning and sunstroke. Meat is, in fact, almost as deadly as bread and potatoes, while we have no such ingenious machinery to keep it from killing us.

It becomes the part of wisdom, therefore, to keep the protein intake pretty well down to the lower limit. "Omnivorous man," it has been cleverly said, "who in his omnivorous privilege has a choice of foodstuffs, does not, *when wise*, feed his furnace fires with protein, any more than he would stoke the furnace of his house with fine brass-bound cabinet furniture. The metal fittings, in such case, would not burn, and their warped and twisted shapes would only clog the grate, while costly carved rosewood or polished mahogany would give no more heat than plain pine sticks. In other words, the oxidation of the large amount of

protein necessary for fuel service would mean a serious tax upon the energies of liver and kidneys, and an impregnation of blood and tissues with a considerable proportion of more or less poisonous waste products, all for the sake of a combustion yield of energy that could be got just as well out of simpler and safer foods."

Theoretically, it should be possible to pick just the right combination of food proteins to give just the right amino-acids to build the proteins of the body, and thus to cut down the total intake below a single ounce a day. Practically, since mankind insists on eating real food, general experience in Western Europe and America has pitched upon about four and a half ounces as the working minimum.

The real difficulty is to avoid eating a great deal more. The Russian peasant, living entirely on black bread, and eating the three pounds or more that it will take to do the day's work, gets five ounces of protein along with it. If he lived on milk, he would get seven. The Irishman of tradition fed on potatoes. If

he had actually eaten nothing else, the eight pounds needed daily to cover his energy requirement would have given him three ounces of protein. He actually did eat a great deal of oatmeal, which is sixteen per cent proteins. Even rice, that special bugaboo of persons who believe in high living, affords nearly three ounces of protein along with the starch for a day's work.

Practically, of course, nobody ever does eat bread or potatoes or rice or oatmeal and nothing else. And the something else commonly jumps the protein well above the minimum limit. Dried fish, with which the Japanese piece out their rice, lean meat, peas, beans, cheese, nuts, are all from a fifth to a third proteins. The fruits and the fresh vegetables, though mostly water, commonly have a tenth, and sometimes have a third of their dry solids proteins. Clams and oysters, and the fishes that are not oily, leaving out the water, are four fifths and nine tenths. Sugar, and the cooking fats are virtually the only foods that are quite without NH_2.

In other words, we well-fed American citizens, doing enough work to give us an appetite, and needing say twenty-five hundred calories to work on, can only by careful planning keep our protein intake down anywhere near the four-and-a-half-ounce minimum. Many prosperous American workingmen in the cities probably get twice more than is good for them. A few sedentary men, however, and not a few women, doing less than two thousand calories of work and eating lightly, are down close to the lower limit.

Just where this lower limit is, is by no means so certain as it seemed a decade ago. The four and a half ounces of the so-called Voit standard was determined by observation of what European laborers actually do eat. How much less they might have eaten, and whether the four and a half ounces is really enough, has had to be found by experiment.

Voit himself thought the four and a half ounces too much. He was familiar with the German army ration which gives nearly an ounce less, or about half the amount of the

United States army ration; and he also studied, a quarter of a century ago, the case of a vegetarian who held his protein intake below two ounces.

Within this century, Mr. Horace Fletcher's week with the Yale crew in training was done on one and three quarters ounces of protein daily, although he weighed a hundred and sixty-five pounds and had not been exercising. Now for some ten years, moreover, Mr. Fletcher claims to have lived in uncommonly good health and to have kept up his bodily repairs on about this intake.

Chittenden's famous "hunger squad" was made up of five University professors busied with their teaching, eight student athletes in training, and thirteen soldiers from the regular army, who followed the ordinary routine of garrison duty. The men were also of all sizes from less than a hundred and twenty pounds up to more than a hundred and eighty. The trial lasted five months, and all the subjects remained throughout in "nitrogenous equilibrium" — that is to say, the intake of NH_2

in the food balanced fully the protoplasmic waste.

The largest eater of the lot, one of the athletes and a big man, consumed only two and a half ounces of protein daily. The largest man of them, also an athlete, was down virtually to two. One of the professors, a little man, weighing only a hundred and thirty pounds, lived throughout the entire period on a daily protein allowance of one ounce and a quarter.

Incidentally, it is interesting to note that the middle-aged professors, sitting at their desks, actually used for their protoplasmic renewal more than eighty per cent as much food as the husky young athletes who were winning championship games, and ninety-four per cent as much as the soldiers under military régime. Leaving out the little professor who lived on air, the professional men and the laborers are virtually level—a very pretty demonstration, if one were needed, of our modern doctrine that the working muscle does not consume the living part of its own substance. The instructors needed nearly a

fifth less protein than their pupils because they actually were just about a fifth smaller men. Chittenden himself, for a year and a half, held his own protein intake below one and a half ounces, with considerable improvement in health and muscular endurance. The Scandinavian physiologist, Siven, thirty-two years old and weighing one hundred and forty-five pounds, kept his body proteins intact for short periods by taking in but one ounce with his daily food. By picking his proteins wisely and then helping them out with just the right amino-acids, he actually reduced his intake to slightly more than half an ounce, or just about the daily waste of the living tissue itself when the diet is ample but contains no NH_2.

In other words, the "Voit standard" of four and a half ounces turrs out to be based less on the real needs of the body than on the demands of an appetite evolved to meet the conditions of primitive society, when hunters went hungry for a week, lived on their own tissue, and then made it up at one vast gorge.

The human appetite for proteins is not adjusted to regular civilized life. The "Chittenden standard," two ounces of protein daily, is quite sufficient — if one gets it in the right form and every day.

Clearly, then, if the low-paid laborers of Europe, who are the raw material of the Voit standard, are getting more than twice the protein that they need, the practical danger that any one of us will get too little is quite negligible. People who get enough to eat at all, will always get enough of the amine radical along with it.

XIV

SALTS AND SAVORS

THE paradox of nutrition is the importance of the non-nutritious foods. All the water we drink in a year will not wink an eyelid, yet we die more promptly for lack of water than for lack of all nutritious foodstuffs combined. The amino-acids of the proteins which we actually build into our protoplasm are hardly a mouthful a day. But without that little, life cannot go on. The merest pinch of various salts determines whether we get any good whatever out of all the rest of our food, so that without these salts, we lie down and die of starvation just as promptly on three square meals a day as if we tried to live on air.

We use lime salts to form our bones — phosphates, carbonates, chlorides, and fluorides, with some magnesium. Without these we should be as spineless as Burbank's new cactus.

Other phosphates are built into the living protoplasm. Common sodium chlorid yields the acid of the gastric juice and salts the blood. The tissues themselves are salted with potassium. All the proteins contain sulphur. "There is iron in the blood," in the hæmoglobin; without it we could not breathe. The body always contains lithium and silicon, and occasionally manganese, copper, and lead.

The balance of these various minerals, also, seems hardly less important than their presence in blood-stream or sea-water. A little more lime in place of table salt checks the heart-beat and paralyzes all the voluntary muscles. A little more table salt in place of the lime sets all the muscles to beating rhythmically like hearts. With just the right amount of this, that, and the other metallic ions, we have eggs developing with only one parent in place of the customary two, embryos trying to grow up without any hearts, cyclopean monsters with one medial eye, and a whole museum of all sorts of strange creatures, each made by the particular medium in which it

has grown up. But a tough old lobster will not live five minutes in cold fresh water.

The animal body, in other words, is not merely a chemical machine, it is a chemical machine built to run in some particular salt solution. In ways that are only partly understood the non-nutrient salts of the food control the interaction of the living tissue with the nutrients.

Even less understood are certain uncanny organic substances, the vitamines. The plants, apparently, make them; and then they are passed along from animal to animal like the proteins, until they run out or are destroyed by over-cooking. Their quantity in the body is of the general order of one part in a hundred thousand. But in their absence we sicken of some disease of mal-nutrition, like scurvy, rickets, beri-beri, or pellagra, which are the penalty of a one-sided diet.

Fortunately, however, all this varied array of essential food elements takes care of itself. We eat the flesh of other living things, which always, by the same token, have all the

elements necessary for life. Without taking thought and quite in spite of ourselves, we take over their supply. Common salt is the only non-nutritious solid which we deliberately add. Foods as they come, with "salt to taste," give us a great deal more of all these things than we can ever use.

To this, nevertheless, there is one exception. The fluid that nourishes our infancy is short of iron. Therefore we arrive in the world with enough extra stored in our livers to keep us going for about a year. After that, for the remainder of our days, we risk anæmia if we fail to eat eggs, meat, green vegetables, or some other special iron-bearing food.

It is, therefore, sheer superstition to consider fish to be "brain food," because it is rich in phosphorus; or to prefer whole wheat bread to white, because the bolted flour "has been robbed of its phosphates." The facts are correct. Fish and nervous tissue are long on phosphorus. Graham flour does have three times the mineral matter of the ordinary sorts. But when other foods have already more than

enough, why load the body with the task of getting rid of any further supply? Because a naked man is chilly, it does not follow that we need any of us wear two shirts.

Hardly less important than the pinch of various salts in our viands are the various essential oils, fruit acids, condiments, and the like, that please nose and palate. These have little or no real function in the body. Apparently we never make them into flesh or blood, while if we ever get any work out of them, the amount is likely to be too small to measure. Yet the animal body is built to like certain things; and in general, what we do not like is not good for us. Practically, therefore, it is quite as important that food should be appetizing as that it should be nutritious.

To this there is, again, one exception. The special flavors of meat and fish are due to a different group of bodies from those of most other foodstuffs. Instead of being essences of the general nature of the perfume of flowers, they are the decomposition products of the working muscle, broken-down proteins on

their way to excretion. They are, in other words, more of those troublesome amino-bodies which arise from all protein food.

If, then, we take our proteins as cheese or nuts, we have to get rid of only the nitrogen of the nutrient itself. But if we take the same quantity as fish, flesh, or fowl, we must in addition get rid of the nitrogen of the "extractives" which give the flavor to them all. Hence follows the time-honored practice of reducing the meat consumption of the gouty and the rheumatic, who are being poisoned by their own protein derivatives.

Many "meat extracts," "invalid foods," "concentrated foods," "brain restorers," and the like, consist largely of these same extractives. So, too, does the ordinary household "beef tea." Their agreeable flavors are usually a harmless indulgence, but they are in no sense proper foods, for they commonly leave the body without being put to any use.

Finally, there are the alkaloids, as we get them in tea, coffee, and in various other drinks under all sorts of misleading names. All these

are poisons, and dangerous habit-forming drugs. Beer, wine, and distilled liquors, though they are all true foods, are practically in the same boat as the alkaloids.

Oddly enough, alcohol in the blood is also in the same boat with the superfluous proteins. The oxidizing of the one and the splitting-off of the amino group from the other both yield energy, but only in the form of heat, never as muscular labor. They two are the sole exception to the rule that all foodstuffs do any kind of work.

Evidently then, there are many important, valuable, and even essential foods, which are either quite non-nutritious or else are taken in such small quantity that their nutriment is practically negligible. The half-pint of clear soup which introduces a dinner may be good for only twenty calories of actual work, and yet may put a tired diner into a state of mind and body to utilize the thousand or more which follow it. The onion of stew or chowder is nothing — but it makes all the rest easy to eat. Cucumbers and celery, radishes and

lettuce help out the appetite far more than their eighty and ninety calories to the pound helps out the nutrition. Even the habit-forming drugs may on occasion be justified by their indirect good.

One gets a striking illustration of this principle in the case of salads. Nobody wants to eat cold scraps out of the ice-box. Dry crackers are not appetizing in spite of their two thousand units of nutriment; nor olive oil, straight, for all its forty-two hundred. But add a few ounces of lettuce leaves and a few drops of vinegar, rub a bit of garlic or a slice of onion on the dish, and behold an attractive and nutritious meal. The onion and the vinegar carry the lettuce; the lettuce carries the oil; and the salad carries the crackers. The less nutritious portion is the price of eating the rest.

"Pure" foods are largely flavorless. "Is there any taste in the white of an egg?" — or in any other unadulterated protein, or in any fat, or in any carbohydrate except the sugars? The art of cookery consists in sophisticating

still further with agreeable essences, the food-stuffs which Nature has already contaminated with inorganic salts.

Practically, therefore, this whole complicated question of the non-nutritious foods is taken care of by the simple device of drinking plenty of water, eating plenty of potatoes and bread, a reasonable amount of fruit and garden stuff; and after that, eating, if not always what one likes, at least never what one does not. After all, the appetite is a great deal older than chemical physiology, and in most small matters, much the safer guide.

XV

THE BALANCED DIET

THEORETICALLY, it should be possible to do without the entire starch-sugar group or to dispense with all the fats and oils. As a matter of fact, a starving man is really living on a fat-protein diet, while the Eskimo, living where there is no vegetation, must perforce live entirely on the fat and proteins of other animals. On the other hand, the Japanese laborer or soldier, living on rice, green vegetables, and dried fish, comes pretty close to getting no fat at all. Neither people seems to be any the worse for its one-sided diet. The one simply builds fat out of starch; the other splits sugar out of protein.

Nevertheless, there is a certain practical advantage in distributing the intake of each meal among the three main foodstuffs. Each of these has its somewhat special place in the bodily economy. Each also has a special

apparatus for its digestion, which works best under a steady load.

Now man is a starch-eating omnivore. That is to say, he seems on the whole to thrive best on a mixed diet that is half starch, with no small part of the remainder the various sugars. Starch, properly and sufficiently cooked, and properly taken care of in the mouth, is the one food which never makes any trouble anywhere in any normal body. Its digestion is simple. It has no by-products, either good or bad. It burns clean, and its end-products pass off harmlessly with the breath. Altogether it is the one safe food, the foundation and the first and second stories of any rational diet.

General experience in Europe and America supplements the starch-sugar ration by about one tenth fat by dry weight. Hospital dietaries run from six to eighteen per cent. The Voit standard lies between eight per cent for light work and thirteen for heavy. Wood's and Mansfield's Maine lumbermen, chopping in the cold, took a quarter of their food as fat.

Since, however, the fats and oils are more than twice as nutritious as other foodstuffs, the tenth or the quarter by weight, means a fifth or a half the day's energy.

It is a simple matter enough, using the ordinary tables, to figure out the fat content in any meal, and to make sure of the tenth by dry weight or the fifth by energy. But it is not commonly worth while. People vary so much in their liking for fats and their ability to handle them, there is so much idiosyncracy of all sorts, that mere averages have little meaning, and one man's meat is another man's poison. Practically, the most that cook can do is to avoid a run of especially fat dishes or of especially lean ones, and to give each member of the household a certain amount of leeway in each meal. Persons who cannot eat much cooked fat have to make it up with butter, cheese, cream, nuts, and oil. Persons who cannot eat more than a little of any sort ought to have a chance to dodge what they do not want. Each one may well make sure of some fat at each meal, and try on the whole to

keep the amount rather up than down. Beyond this, appetite and judgment are usually sounder guides than chemistry and arithmetic.

The proteins also, among civilized peoples, commonly run to a tenth or more of the dry weight of the daily food; though certain wild tribes of hunters go to a half. A starving man takes thirteen per cent of his day's energy out of his body proteins. Voit's standard calls for fifteen per cent; Chittenden's for eight; Siven managed with five. General scientific opinion of the day is that Voit's standard is unnecessarily high, Siven's impractically low, and Chittenden's entirely workable only if applied with uncommon wisdom. As we should perhaps expect on grounds of theory, the varied diet and better cooking of the well-to-do classes seem to permit a slightly lower protein intake than is advisable for the poor.

A remarkably large number of the main staple foods which the human race has been eating these hundred thousand years have their protein content between the Chittenden and the Voit standards. Rice and rye lie

close to the lower limit. Potatoes and corn meal have almost exactly a tenth of their total energy in their proteins. The crude starchy vegetables, so far as they are anything but cellulose and water, average close around this fraction. Wheat and oats run thirteen and fifteen per cent proteins, with nothing to choose among Graham, whole wheat, and white flours, breakfast foods, macaroni, or plain old-fashioned bread.

The ancient staff of life, eaten alone, hits the Voit standard about as closely as the wayfaring man can measure. Spread moderately with butter, the combination drops its protein to the Chittenden standard, and hits accurately the correct proportion of fat. Bread and butter is, therefore, the normal human food, the paragon of viands. Everything made with flour, and a little "short," — that is to say, all cookies, cakes, crackers, virtually everything to be bought in a bake-shop except doughnuts and pies, — are only other forms of bread, and like it are theoretically right.

The fattest cuts of meat also, especially mutton and pork, have not far from the proper protein content. Since, however, they contain virtually nothing of the starch-sugar group their "balance" is otherwise entirely wrong. Butter, oil, the clear fats of meat, and the like have virtually no protein. The fruits, also, whether dry or fresh, are all low — from six per cent down. So, too, are all forms of nearly pure starch and sugar — arrowroot, corn-starch, tapioca, candy, sirup.

All forms of muscle, on the contrary, soar far beyond even the Voit standard. Average cuts of beef run twenty and thirty per cent protein; lean cuts go to fifty and seventy. Salmon, though among the fattest of fishes, is half protein; the white fishes are three and four parts in five. Fowl is about like fish. Eggs have a third of their energy in their proteins, with the whites nine tenths.

Nuts average around the Voit standard, with a range from ten to twenty per cent. The cheeses are from one quarter to three quarters protein according as they are more or less fat.

Butter and cheese together, therefore, cover the entire range of the meats, with milk at twenty per cent protein, not far from the average of everything in the butcher-shop.

Curiously enough, virtually all our time-honored combinations — pork and beans, beans and brown bread, doughnuts and cheese, cheese with apple pie, meat and potato, fish and potato, crackers and milk, liver and bacon, bacon and eggs, mush and milk, oysters and crackers, — all have one member of the pair markedly above the Voit standard and the other distinctly below, so that the two average pretty close to the customary fifteen per cent. Normal human appetites seem to gravitate naturally toward that demand.

Since, however, normal human appetites seem to gravitate with equal unanimity toward beer, the normal human appetite is by no means good authority, and is probably quite wrong in thinking it needs the Voit standard of proteins. Voit's allowance is more wisely taken as a maximum, from which the philosopher, as inclination and habit per-

mit, works down toward the Chittenden standard. Certainly there is no ground, either in theory or in experience, for ever eating meat or fish oftener than once a day — still less for the pound at a meal that is rather in the manner of a primitive savage than a rational man.

With our American customs, therefore, the actual practice of "balancing" meals resolves itself into keeping down the intake of proteins in each single one. The great mass of nutritious foods, including potatoes and everything made of flour, are about right anyway. If, then, we add, for flavor and variety, meat, fish, eggs, cheese, game, nuts, — as we practically must, — we may well avoid making both the piece of resistance and the dessert highly nitrogenous, and not lunch on fish or scrambled eggs on the same day when we dine on roast beef.

XVI

FIGURING A DIETARY

LET us for the moment turn from all matters of theory to certain actual meals — to a portion of those already figured for total nutrition without regard to the form in which it comes.

The bread and butter of the Continental breakfast gives, from the tables, in calories: —

	Proteins	Fats	Starch-sugars	Total
Bread (1 oz.)	(9.3)	(3.7)	(63)	(76)
4 oz.	37.2	14.8	252	304
Butter (1 oz.)		(228)		(228)
½ oz.	—	114	—	114
Or for the bread and butter together	37.2	128.8	252	418
Dividing the separate items by the total, the percentages become,	8.9	30.8	60.3	100

In other words, our plain bread and butter alone is very close to a perfectly balanced meal. A certain frugality with the butter would bring the ration a great deal nearer

the theoretic one tenth proteins and one fifth fat than a carefully dieted hospital patient always gets to his prescription.

But the traditional breakfast includes coffee. "Coffee with sugar and cream," may be a great many different compounds, according to the number of lumps of the one and the color of the other. A fair guess will be: —

Proteins	Fats	Starch-sugars	Total
10	40	50	100

This gives for the entire breakfast: —

	Proteins	Fats	Starch-sugars	Total
Calories	47.2	168.8	302	518
Per cents	9.1	32.6	58.3	

The meal is then somewhat over-fat and possibly a little short of proteins. The fats, however, are the especially digestible cream and butter, while succeeding meals are pretty certain to be long on proteins. Altogether, the universal practice of Western Europe is amply borne out. The addition of jam, after the English manner, to replace part of the butter, would do away with any excess of fats.

But suppose there are children in the family, who are given milk in place of coffee — a good old-fashioned mugful amounting to a fair half-pint. The milk will figure: —

Proteins	Fats	Starch-sugars	Total
29.6	85.6	44.8	160

And the entire meal then becomes: —

	Proteins	Fats	Starch-sugars	Total
Calories	66.8	214.4	296.8	578
Per cents	11.6	37.1	51.3	

Evidently the meal is ample in quantity, and about ideal in quality for a growing child who, as we shall see later in more detail, needs much more fat than an adult. The immemorial diet of childhood turns out to be a wise choice.

And finally, not to ring the changes to weariness, let us convert our milk into chocolate by adding: —

	Proteins	Fats	Starch-sugars	Total
Sugar, ½ oz.			58	58
Chocolate	12.	57.5	20.5	90

Or for the entire meal:—

	Proteins	Fats	Starch-sugars	Total
Calories	78.8	271.9	375.3	726
Per cents	10.8	37.4	51.7	

In other words, any meal of bread with butter or jam, and any of the ordinary drinks from water to thick chocolate, is without any taking thought whatever, already balanced as to its proteins. An ounce of butter is "isodynamic" with a little less than two and a half ounces of jam or marmalade — and this is just about the ratio in which the child of nature spreads them. All jam, therefore, in place of all butter, will merely shift 114 calories from the "Fat" column to the "Starch-sugars," and drop the proportion of fat near or well under the normal fifth — 3.6 per cent, 10.6, 17.4, and 21.4 for the four meals in order. Evidently, then, a butterless meal needs cream, chocolate, or some other form of fat.

The more elaborate, "American" breakfast figures: —

	Proteins	Fats	Starch-sugars	Total
1 orange	6.5	3.5	90	100
5 oz. breakfast food with cream and sugar	11	34	55	100
2 eggs, 4 oz.	60	120		180
2¼ oz. bread and butter	18.6	64.4	126	209
1 cup coffee with cream and sugar	10	40	50	100
Calories	106.1	261.9	321	689
Per cents	15.4	38	46.6	

The obvious effect of the customary two eggs is to jump the proteins from the Chittenden standard of the "Continental" breakfast to the Voit standard. Otherwise this more elaborate meal does not differ appreciably from the simpler one.

Our American breakfast formula seems to be (1) some sort of fruit to liven the appetite; (2) something with sugar and cream to deaden it; (3) something to eat. The net result is about the same as the European practice of taking something to eat to start with and letting it go at that.

A single case will be sufficient illustration from the meals other than breakfast:—

	Proteins	Fats	Starch-sugars	Total
Beef tongue, 1 lb.	370	370		740
Bread, 8 oz.	74.4	29.6	504	608
Spinach, 3 lbs. 13 oz.	152.5	48.8	225.7	427
Olive oil, 2 oz.		527		527
Potatoes, 1 lb. 7 oz.	60	7	486	553
Butter, 1 oz.		225		225
Flour, 2 oz.	18.4	7.4	178.2	204
Skimmed milk, 1 pt.	64	13	93	170
Cookies, 3 oz.	27	120	213	360
Coffee jelly, sugar, 6 oz.			696	696
Calories	766.3	1347.8	2395.9	4510
Per cents	17	30.	53.	

Here, then, is an entirely "random" meal, the cook serving what was handy, and six hungry campers eating what they liked. Yet the fats are about as close to theory as taking thought would have made them, while the total intake, 750 calories for each, though somewhat large, is not excessive for the chief meal of the day. But the proteins are twice the Chittenden standard and well above the Voit. For the proteins creep in everywhere in surprising quantity and mount up fast.

Virtually half the protein of this meal is in the meat. Suppose, then, that the meat had

been left out. The balance would then become: —

	Proteins	Fats	Starch-sugars	Total
Calories	396.3	977.8	2395.9	3770
Per cents	10.5	26	63.5	

In other words, even so small a quantity of meat as one pound in a meal for six persons — and even that little distinctly fat — shoots the proteins well above even the Voit standard and overtops the Chittenden standard more than two to one. As anybody may prove for himself simply by trying it, in a meal containing meat or fish, only extraordinary pains will keep the proteins down to even the upper limit.

In addition to this obvious method of balancing a meal or a dietary by simple arithmetic, there are several ingenious devices which make use of printed cards. For professional dietitians, working on a large scale, these save time — after one has mastered them.

But for the amateur trencherman, it is with the ration balance as with the total energy —

the main thing is to train appetite and judgment, to independence of cards or scales. For most of us, it is quite enough, when in doubt, to keep the proteins down and the fats up, and now and again to figure a meal or two to see how our practice conforms to theory. Always, nevertheless, one may depart far from the average of mankind, or from his own usual practice, and still be right.

XVII

THE GROWING CHILD

ONE of the curious things about a baby is the amount of work he does. The fœtal heart-beat is twice as rapid as that of the adult, and only gradually through childhood drops down to the grown-up rate. The lungs of youth pump to correspond. All the bodily processes are rapid. The tissues are all quick capital, growing and changing and fluid, not salted down to a permanent investment, like the bones and sinews of an adult. The child is very much alive, and makes real work of his living.

In other words, while a big man at light labor takes sixteen or seventeen calories for each pound of body weight and, while Mr. Horace Fletcher in his week with the Yale crew kept his below ten, thirty calories to the pound is the irreducible minimum for an infant, and a very young baby demands a full

forty-five. A child under ten months old will actually do five hundred and six hundred calories of work in a day, and add a full quarter to the load of the mother who nurses him. Only a very exceptional man — a runner in a long race, a soldier on a forced march, a refugee fleeing for his life — equals, weight for weight, the actual day's toil of a helpless infant. Not till some time after he dons his first "pants" does an active boy drop to the level of a hard-laboring adult.

Quite erroneous, therefore, is the common impression that the voracious appetite of childhood is due to any special call for food to grow on. Increase of bulk from birth to adolescence does not amount to a hundred pounds in fifteen years — say roughly, a hundred ounces a year. A tenth of an ounce dry solids of a meal, or let us say a cup of milk once in four days, covers amply the average growth quota from infancy up.

To be sure, a very little baby during the first weeks of life does grow an ounce a day. But by the time it begins to sit up and try to talk,

the increase has dropped to a half or a third of an ounce, while an infant of nine months may take four hundred and eighty calories of milk a day, use up four hundred and twenty in its day's work, and grow the other sixty. Even at this early age, therefore, seven eighths of the daily intake goes into "work" and only one eighth into growth. Cold figures give little support to the eat-to-grow superstition.

Nor is there more basis of fact for the general opinion that because children are growing they need an extra ration of "tissue-building foods" — that is to say, of proteins. For, in the first place, if we dry out the water, the body commonly contains more of either fat or bone than of the traditional "tissue-builder," while it takes some six times as much food to build an ounce of passive fat as of working muscle. In the second place, an infant, using one eighth of his intake for growth, is at the same time doing twice the work, pound for pound, as a grown man, and should therefore need less protein in proportion, not

more, even if the growth were all muscle instead of more than half fat and bone.

As a matter of fact, a baby maintains itself on five per cent proteins and ninety-five per cent sugar and cream, and grows normally on two per cent more of protein, making seven in all. In other words, the human infant lives on the Siven standard and thrives on the Chittenden, leaving to his elders the fourteen per cent proteins of the Voit.

Corresponding to this low protein intake of the normal baby, the milk on which he was intended to be fed has only from seven to ten per cent of its total energy in its proteins. Cows' milk, to be sure, has twice and three times this amount — but a calf grows some twice and three times faster than a baby. Puppies and kittens, who double their birth weight during their first week of life, are fed on five times the protein of slow-growing man. In other words, the general impression that babies and children need much "tissue-building foods" is based on the natural food of creatures which build tissue three, four,

twenty, times as fast. On abundant and well-chosen food, a human being may well maintain throughout life the eight or ten per cent of proteins on which Nature and Professor Chittenden agree.

The proper difference between a child's food and a man's lies in the fats. Human milk varies greatly with the age of the infant and the general health of the mother. Roughly, however, it splits just about even in energy content between milk-sugar and fat, or virtually forty-five per cent of each. That is to say, a baby does about half its living on fat, as against a fifth for an adult. Nature, in short, starts the little human on twice as much fat as he will handle later. Wisdom suggests dropping down the fat intake only gradually to the adult level.

Incidentally, one may note that there is no possible way of "modifying" cows' milk to make it fit food for a human calf. *Au naturel*, it contains more than twice too much protein, five times too much lime, and a third too little sugar. Dilute with two or three parts of water

to make the proteins right, the fat and sugar are all wrong. Add cream and milk-sugar, and the mineral salts are still off — too much lime, too little iron, and the wrong amount in varying degrees of six other portions of the "ash." Moreover, "protein" of the formulas covers a half-dozen actual proteins, which are no more the same in human and bovine milk than in human and bovine blood or muscle. No wonder there are districts where, of babies fed on real food, only fifteen per cent die; and of babies fed on imitations, only fifteen per cent live!

Speaking, then, in very round numbers, we may properly hold our proteins nearly steady through life at about one tenth the total intake, while between babyhood and voting age we drop the fats from two fifths to one fifth, and take up all the slack with the starches and sugars. We keep going for the first few days of existence on some one hundred and fifty calories a day, and touch three hundred before we are two weeks old. A weaned child is running seven hundred. At nine years

of age he needs half the food of most adults. At twelve, he demands fifteen hundred calories, and can be persuaded to eat more. After sixteen he becomes virtually a small adult, with no special quality due to his youth.

In the light of these figures, it is by no means certain that all carefully reared children really get enough to eat. Too much thin stuff, — fruit, cereals, milk, potatoes, eggs, fish, meat from which every bit of fat has been carefully dissected out; too little bread and butter, cookies, crackers, cakes, candy, jam, and olive oil, may form a diet with too little energy for its bulk. A child's food needs to be easier to digest than an adult's; but it should be more rather than less nutritious.

XVIII

OF CERTAIN SPECIAL DIETS

THERE is a story told of a certain victim of "oil dropsy" who consulted a famous authority on the affliction, and received the customary lists of viands which he might and might not eat. Unfortunately, he interchanged the two, and ate steadily away on the fattening foods which he was supposed to shun and carefully avoided everything that he was supposed to take.

Nevertheless, he whittled down his outline and got back his figure. With half the things he liked forbidden him, he had simply eaten less. Intake dropped below outgo, and the man lived on his capital until his reserve came down to normal.

For there is, of course, no such thing as a "fattening food." The desk-worker who, as he passes forty years, begins to neglect his exercise, the laboring-man who gets a place

on the police force, the mother who puts her child on solid food and no longer has to furnish seven hundred calories a day, all, if they are not careful, put more food into their mouths than they burn in their muscles. The excess results, as a logician would say, in an undistributed middle.

It all comes down, therefore, with healthy people, to Micawber's old formula, twenty shillings a week income and nineteen outgo. We put two thousand calories of foodstuffs into the blood-stream, and we take out nineteen hundred in work. The other hundred calories piles up. It does not make the slightest difference where it came from.

All flesh-reducing diets, therefore, involve mild starvation. We leave off potatoes, bread, vegetables, and the like, which are somewhat tasteless and of which we have been eating more than we realize. One can easily nibble a hundred calories of bread absent-mindedly between courses. We also leave off desserts of various sorts, pies, puddings, sweets, which are apt to be pretty nutritious, and certain

to be eaten after we have really had enough already. Sometimes we are told to leave off fats, on the ground that they are nutritious. Sometimes we are ordered to take them because they spoil our appetite for other things.

Banting's famous method pushed this general idea to the limit. He put his patients on lean meat. Now, lean meat, to begin with, is worth only some six or eight hundred calories to the pound. It has, in addition, so marked a flavor that it soon kills the appetite; as much as a quarter of its energy may go to waste heat; and finally, the fiber of even the best is so rubbery that no human jaw can possibly chew enough for its owner to live on. So Banting got his patient four ways at once, and promptly starved him into shape.

Von Noorden's much more scientific régime is worth giving in full: —

Eight o'clock: three ounces of lean cold meat, one ounce of bread, one cup of tea with a spoonful of milk but no sugar.
Ten o'clock: one egg.
Twelve o'clock: one cup of strong meat broth.

One o'clock: a small plate of meat soup flavored with vegetables, six ounces of lean meat or fish, three and a half ounces of potatoes with lettuce, the same weight of fresh fruit without sugar.

Three o'clock: cup of black coffee.

Four o'clock: seven and a half ounces of fresh fruit.

Six o'clock: a half-pint of milk, with tea if desired.

Eight o'clock: four and a half ounces of meat either cold or hot, with pickles, radishes or salad, an ounce of Graham bread, and two or three spoonfuls of cooked fruit without sugar.

The eight meals a day keeps the patient from becoming faint, although the ration figures out only about sixteen hundred calories, of which nearly half is in the meat.

The other five hundred or more, the patient takes out of his own fat. Counting this as worth four thousand calories to the pound, he should, of course, lose at least two ounces a day.

Oertel's dietary is still more rigid. He allows only three meals, with afternoon tea, and cuts the total intake below twelve hundred cal-

ories, of which meat and eggs comprise more than half.

In other words, the fat man and the man in condition follow opposite policies. The one keeps his proteins fairly low, but makes sure that his total calories are well up. The other keeps his total calories down below his real needs, so that he shall do part of his day's work on his own too abundant flesh. But he keeps his proteins well up, so that the wasting shall come on his reserve of fat, not on his living tissues.

As there are no special "fattening foods" to be avoided by the too rotund, so there are none to be sought by the over-spare. Here again it is simply a question of total calories in and total calories out. We gain flesh, then, by dodging the bulky innutritious foods which fill the stomach with cellulose and water, the indigestible viands which fail to reach the blood-stream at all, and the too pronounced flavors that kill the appetite. One can add calories, as cod liver oil, or malted milk, or any one of some score of special foods. The

obvious device is to get outside another slice of bread and butter. In short, the proper diet for an over-lean adult is much like that for a growing child, nutritious, digestible, appetizing, and somewhat carefully balanced.

Three other classes of men may in theory do better on the over-balanced, high-protein diet of the fat and scant of breath.

The convalescent from a wasting disease has been spending his tissues riotously. A high fever may cost six or eight hundred calories a day above the maintenance level of health, and on a diet that does not reach half the starvation minimum. No small part of the difference has to be taken out of the muscles; hence comes the ravenous appetite of couch and steamer chair, and the hunger for proteins to build anew lost protoplasm. Here the special call is for the "high-grade" proteins of meat, eggs, milk, rice, and potatoes, which give the full list of amino-acids and in the best proportion.

In certain ways like that of the convalescent, is the case of the overworked man, or

let us say, the sedentary worker who takes a strenuous vacation without waiting to get into condition. The regular hard worker, as we have seen, should have a diet somewhat low in proteins and distinctly high in fats. But the ill-conditioned worker will not digest an excess of fats, while his unused muscles, instead of feeding themselves economically out of the blood, tend, apparently, to "go stale" and spend their own protoplasm. General experience is, therefore, that a student athlete going into training, a desk-worker shifting to hobnails or snowshoes, will best protect his unaccustomed muscles with liberal protein and sugar, and take on only slowly the proper laboring diet. Sugar, especially the fruit sugars, which do not have to be digested, are traditionally the best quick meal for an exhausted muscle. The proteins are in some ways even better.

Finally, there is the slender person who has to face unaccustomed cold. In the long run, to be sure, the fats are the richest store of warmth, as of other forms of energy. But for

a few unwonted hours, the "specific dynamic action" of all proteins when the amino group splits off, and the special stimulus to the heat centers of two or three of them, are a great comfort to chilly bones. For this, all proteins, high-grade or low, are equally good, even to the gelatin of soup and the zein of corn-meal mush.

In all this, however, we touch a field that belongs rather to individual experience and to medicine than to the general theory of nutrition.

XIX

THE CASE FOR THE VEGETARIAN

MUCH of the argument for vegetarianism and against it is simply *de gustibus*, and therefore *non disputandum*. Some persons there be who simply do not like meat, as others do not care for olives or do not take sugar on their lettuce. All that one can say, impersonally, on this point is that the extractives which give the taste to meats are, in general, so much more powerful flavors than the essential oils which occur in other foodstuffs, that the more delicate essences are completely swamped, much as all subtlety of color disappears in the glare of a bright day. The palate, therefore, becomes tuned to a somewhat limited number of violent flavors, which in time become monotonous. Notoriously, one cannot eat quail every day for a month.

On the other hand, general testimony is that, with the omission of the highly flavored

extractives of the meats, a vastly greater number of delicate essential oils make their appearance, like out-of-door colors in the rain. Many persons, certainly, whose palates have become tuned to the volatile oils find the more conventional diet ill-flavored and uninteresting. All this, however, is only a matter of taste — and cooks.

Many vegetarians, of course, have conscientious scruples against devouring their fellow vertebrates. Many, also, are squeamish over the series of unappetizing processes which lie between ranch or coop or landing-net and the dining-table. With all such considerations we have here nothing to do.

The real strength of the vegetarian argument lies in its arithmetic. The proteins of a well-to-do diet commonly add up to about twice what they should. Practically, we cannot drop out the vegetable proteins, because they come along, here a little and there a little, mixed in with the starches and sugars. One obvious way to keep the proteins down is to drop out the fish, flesh, and fowl — and, in-

cidentally, various waste poisons which have not the merit of being also foods.

On the other hand, there is the possible danger that on a strictly vegetarian diet the proteins may be run down too low. We have already seen that the proteins of corn and wheat are not economical sources of the particular amino-acids which we human beings happen to want. A very strict and conscientious vegetarian, therefore, moved by a zeal that is not in accordance with either knowledge or instinct, might hit upon a combination of foodstuffs that would leave him decidedly short, let us say, of lysin or tryptophan. Whether such an accident ever has really occurred is, of course, another matter.

Furthermore, it would be quite possible, in theory, to take so much of the woody fiber of carrots and beets and parsnips as to check seriously the absorption of the nutrients entangled in the mesh. The thing has been done experimentally — and in argument one is fancy free.

A real danger, however, of a strictly vege-

tarian diet is a shortage of fats. Nuts and olive oil are the two available sources of this highly important stuff — and both are expensive. The rigid vegetarian, therefore, oddly enough, may find himself in the same situation with the slum dweller who lives on bread and tea, and buys for meat only liver, fish, and other lean tissue. Both run the chance of being undernourished.

As a matter of fact, however, ninety-nine in the hundred of self-styled "vegetarians" are not vegetarians at all. To be sure, they eschew such animal tissue as muscle, gland, and fat but they count as "vegetables," butter, eggs, cheese, and milk. Now butter, eggs, cheese, and milk are simply meat without the flavor — and especially valuable meats at that. With these *ad libitum*, there is not the slightest danger of running short of either proteins or fat, while their amino-acids do not differ appreciably from those of muscle. In other words, the actual "vegetarian" is simply a person who cuts out certain kinds of meat — the easiest way, on the whole, to

keep down the protein intake to the proper level.

But if butter, eggs, cheese, and milk are to count as vegetables, one might as well go a step farther, utilize the cheap fats of mutton and pork, and without commonly taking lean muscle "straight," employ it for flavoring in chowders, stews, and the like. In other words, what runs up both the proteins and the price beyond reason is not eating meat, but relying on meat for any large part of our day's energy. To buy meat for its fat, and to use the lean to help out the taste of vegetables and flour, as we eat our ha'penny worth of cheese with an intolerable deal of spaghetti, is to seize upon all the real advantages of a "vegetarian" regimen without its drawbacks. Just this, year by year, an increasing number of persons are actually doing.

Curiously enough, this practice is really a return to the immemorial diet of our race, which, for better or worse, has helped to make us what we are. In prehistoric times, and all down through the Middle Ages, while

a small group of great nobles and upper clergy feasted on venison and capons, the great mass of laborers, artisans, farmers, merchants, and fighting men, who were making civilization, lived on bread, cheese, butter, porridge, cakes, and the products of their gardens, while the peoples of southern Europe had, in addition, chestnuts and olive oil. They had almost no meat, "but it be seldom a little lard" or the "bit o' bacon of a Sunday." They raised pork and mutton a good deal for the sake of the fat, and took the lean somewhat as a by-product.

Abundant lean beef, in other words, is a new idea. It came in with cheap freights on the railways and the rise of the great grazing countries overseas. Nomadic barbarian tribes have always lived on flesh, but our own current habit of eating meat three times a day is less than a hundred years old. With the general increase in wealth, the practices which were once confined to a small group of the upper classes have spread through society. Lean meat has replaced cheese as the great

source of protein, and the poor man enjoys the diet which once belonged to the rich alone.

Meanwhile, the more intelligent and well-to-do classes, after three generations of error, are returning to the ancient diet of their people. To-day, many a professional man eats less meat and spends less money on his table than a well-paid workingman with a third his income. The "European breakfast," the "vegetarian" restaurant, Professor Chittenden, Mr. Horace Fletcher, the college-bred women who do their own cooking, are all signs of the times. Let us hope that too many "ists" and "arians" will not make a wholesome tendency ridiculous.

XX

THE LIMITS OF KNOWLEDGE

SO far as the problem of human nutrition is a problem in energetics, its solution is complete. We now know where the day's work comes from, and where it goes to, how much there is of it, and most of the important steps by the way. We know that the Law of the Conservation of Energy holds for the human machine as absolutely as the Law of Gravitation for the celestial mechanism. We may, therefore, trust Bulletin Twenty-eight as we trust the Nautical Almanac — the difference between them is not in the soundness of the underlying theory, but in the number of decimal places in the data.

We are, then, no longer at the mercy of old-fashioned persons who want to feed us on beef extract, of new-fashioned persons who are sure that other people eat too much, of blind guides who advise us in print, of advertisers

of food drinks and magic mixtures guaranteed to contain more nutriment than the sum of all their ingredients. We have only to look up the facts, and know. With butcher and baker and boniface, with anxious relative and persuasive salesman, we may at last deal on the basis of certainty.

When, however, we turn from the work aspect of our daily food to the structure of the working instrument, we find ourselves on a footing much less sure. Science itself does not understand the salts and the proteins in any such wise as it knows the starches, the sugars, and the fats. We have yet discovered neither all the parts of our protoplasmic engine, nor in full how the parts which we do know fit into one another. For this side of the problem of nutrition there is no printed text to which any one may turn as to Bulletin Twenty-eight, the Almanac, and the Dictionary.

No eater of foodstuffs, then, can possibly keep track of a dozen amino-acids and another dozen inorganic salts. The most that Science can advise, practically, is the shotgun method

— a sufficient variety to make sure that, one thing with another, it covers all the ground. We limit the range of our foods at our peril. We take chance of trouble when our total proteins drop much below a tenth of the energy content, or when we miss for more than a day or two some fresh or uncooked food.

On the other hand, enough is rather better than a feast; so that there is no use in hunting round for more phosphates or iron, or in running up the proteins above, let us say, fifteen per cent. Yet even the high protein diet of these United States, *pace* certain dietetic calamity-howlers, commonly does less harm to the body than to the pocketbook.

Of one thing, however, Science is sure. The digestion and assimilation of the food is an extraordinarily complex and delicate process, which is easily thrown out of gear. Each step, if it is to be managed successfully, depends on the end-products of the one before — and the cooking is part of the digestion. Our direct voluntary control of our nutrition begins, therefore, in the kitchen and ends in the

mouth. Whatever goes wrong between the dealer's shelves and the top of the gullet is our own fault.

Beyond this, our control is indirect, through our permanent habits and our temporary mental states. If we eat when we are cross or over-tired, if we hurry, if we talk of disagreeable matters and scold the children at table, we risk letting sundry calories of energy get by unused, and putting sundry hurtful compounds where they should not be. Pavlov's "appetite juice" explains why the dinner of herbs with contentment may contribute more nutrients to the blood-stream than the stalled ox eaten with a disturbed mind.

Ancient experience and modern science agree, then, on this: We need abundant food, enough to cover our living expenses and our work—and no more. We need good food, in the sense that it shall be fresh, and well cooked, and appetizing, and not more indigestible than the eater can stand. Most of us, on the whole, do best on the ancient staple foods on which our race has grown strong

since the Glacial Period, with but cautious excursions into the new and unproved. No food is good of itself, but only as it fits other foodstuffs and the eater. For most normal people it is quite enough to eat at leisure, with a clear conscience and a quiet mind, what one likes and knows he can digest — and when in doubt, to follow Science.

Beyond this, nothing really matters, and all good foods are equally good.

THE END

APPENDIX

APPENDIX

DAILY FOOD REQUIREMENT FOR PERSONS AT LIGHT WORK—RUBNER STANDARD

RUBNER'S standard is larger than Chittenden's and smaller than Voit's and Atwater's. Persons at light work include children at school, professional men, desk and office workers, salesmen, typists, tailors and seamstresses, women doing the lighter parts of housekeeping, and the like. For moderately hard work such as that of a farmer or mechanic, for an athlete in training, for a woman at full housework, and for a nursing mother, add five hundred calories. For very heavy muscular work, add one thousand.

These figures are averages for normal persons. They assume an ordinarily wholesome mixed diet, and allow a reasonable factor of safety over the theoretic optimum. A departure of two hundred calories either way is about the limit for personal idiosyncrasy.

Body weight in pounds	Calories of food per day	Body weight in pounds	Calories of food per day
190	3015	100	1985
180	2910	90	1855
170	2835	80	1710
160	2705	70	1565
150	2600	60	1410
140	2485	50	1250
130	2370	40	1075
120	2240	30	890
110	2115	20	680

PER CENT OF TOTAL ENERGY IN VARIOUS DIETS DERIVED FROM PROTEINS AND FROM FATS

	Proteins	Fats
Siven's minimum	5	
Chittenden's standard	8	
Starvation metabolism	13	87
Voit's standard for medium work	15	18
Voit's standard for hard work	17	26
Human milk	7.4	44
Cow's milk	21.3	50
Maine lumberman	8.3	44
Poor Hindoos	9	10
Finnish peasants	15	21
Well-paid workmen in Western Europe	16	17
Well-to-do Americans	19	30
Eskimos	44	48

TABLES FOR ESTIMATING AND COMPUTING THE NUTRIENTS OF COMMON FOODS

Column one, *Per cent of Water*, serves to distinguish between the obvious bulk of any food and the actual nutrients in it, and permits the estimate of price or intake by reality instead of by appearance.

Column two, *Calories in each Pound*, gives the fuel values. From the weight of foods actually eaten, may be figured, by simple addition, the total intake for a single meal, or the ration for a day, week, or month, of a single individual, of a family, or of any other group. A standard for comparison is given in the table, *Daily Food Requirement for Persons at Light Work*. In the same way can be computed from its ingredients the nutritive value of any special dish not given here, or of any other standard portion.

The data of both these columns are taken directly from Bulletin 28, and are all for raw foods, unless otherwise

stated, and include food actually eaten without allowance for waste or refuse.

Column three, *Calories in each Ounce*, arises by dividing by sixteen the figures of column two. It is for convenience in handling small quantities or avoiding pounds.

These three columns together cover the general problem of food purchase and consumption.

Columns four, five, with column six where it appears, *Calories of energy in each pound contained in Proteins, Fats, etc.*, are computed by multiplying the corresponding percentages of Bulletin 28 by 1860 for the proteins and carbohydrates, and by 4220 for the fats, these numbers being the fuel values per pound of the three pure foodstuffs respectively. The sum of the three is always the *total calories in each pound* of column two.

These three columns furnish data for computing, either in calories or in per cents, the distribution among the three main foodstuffs of the total energy of any ration or special dish. Various standards for comparison appear in the table entitled *Per cent of Total Energy in Various Foods Derived from Proteins and Fats.*

The two, or three, columns following merely give the same information in ounces instead of pounds.

The last two, or the last three, columns, *Per cent of total energy contained in Proteins, Fats, etc.*, arise by dividing the numbers of column two into those of columns four, five, and six. This portion of the tables cannot ordinarily be used for computation, but is the most convenient form for a rough general estimate of the ration balance.

FOR COMPUTING TOTAL RATION

FRESH BEEF

All meats contain also many different sorts of mineral matter, which commonly average about one per cent.

	Per cent of water	Calories in each pound	Calories in each ounce
Very lean	73	560	35
Lean	69	800	50
Medium	60	1200	75
Fat	52	1600	100
Very fat	44	2000	125
Average cuts			
Shank	70	755	47.2
Shoulder	69	805	50.4
Round	68	835	52.2
Chuck rib	67	920	57.5
Chuck	65	1005	62.6
Hind quarter	62	1130	70.6
Fore quarter	62	1135	71.
Side	62	1145	71.6
Loin	61	1155	72.2
Flank	59	1255	78.4
Rump	58	1325	82.8
Rib	57	1370	85.6
Plate	56	1450	90.5
Tripe	86	270	17.
Tongue			
Lean	70	740	46.2
Fat	65	1100	68.7

PRESERVED BEEF

Corned, salted, and dried meats contain less water than fresh; and commonly have more salts up to about five per cent. Otherwise they are like fresh meats.

Since, however, lean pieces are more commonly smoked and dried, and fat pieces corned or salted, average samples are:

	Per cent of water	Calories in each pound	Calories in each ounce
Dried	54	840	52.5
Corned	54	1390	87.
Salt	37	2110	132.

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in		Calories of energy in each ounce contained in		Per cent of total energy contained in	
Proteins	Fats	Proteins	Fats	Proteins	Fats
430	130	26.9	8.1	76	24
375	425	23.5	26.5	47	53
340	860	21.3	53.7	28	72
300	1300	18.8	81.2	19	81
250	1750	15.7	109.3	13	87
400	355	25.	22.2	53	47
370	435	23.2	27.2	46	54
390	445	24.4	27.8	47	53
355	565	22.2	35.3	38	62
355	650	22.2	40.4	35	65
360	770	22.5	48.1	32	68
340	795	21.3	49.7	29	71
350	795	21.9	49.7	31	69
350	805	21.9	50.3	30	70
360	895	22.5	55 9	28	72
350	975	21.9	60.9	26	74
330	1040	20.6	65.	24	76
315	1135	19.7	70.8	22	78
215	55	13.5	3.5	80	20
360	380	22.5	23.7	47	53
255	845	15.6	53.1	23	77
565	275	35.3	17.2	67	33
290	1100	18.1	68.7	21	79
235	1875	14.7	117.2	11	89

FOR COMPUTING TOTAL RATION

FRESH VEAL

Since veal is obtained from a young animal, it contains more water than beef and less fat.

	Per cent of water	Calories in each pound	Calories in each ounce
Very lean	76	500	31.2
Lean	74	600	37.5
Medium	70	755	47.1
Fat	62	1030	64.4
Very fat	57	1350	84.3
Average cuts			
Chuck	74	610	38.1
Fore quarter	72	710	44.3
Hind quarter	71	735	45.9
Loin	70	790	49.4
Flank	70	910	56.9

FRESH MUTTON

Mutton is characteristically fatter than beef.

	Per cent of water	Calories in each pound	Calories in each ounce
Lean	66	940	58.8
Medium	55	1490	93.1
Fat	44	2000	125.
Very fat	30	2700	168.7
Average cuts			
Hind leg	63	1085	67.8
Shoulder	60	1245	77.8
Hind quarter	55	1495	93.2
Fore quarter	53	1595	100.
Flank	43	2065	129.

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in		Calories of energy in each ounce contained in		Per cent of total energy contained in	
Proteins	Fats	Proteins	Fats	Proteins	Fats
416	84	26.	5.25	83	17
387	211	24.3	13.2	65	35
375	380	23.4	23.75	50	50
355	675	22.2	42.2	35	65
335	1015	20.9	63.4	25	75
365	245	22.8	15.3	60	40
372	338	23.25	21.1	52	48
385	350	24.1	21.8	52	48
368	422	23.	26.4	47	53
374	536	23.4	33.5	41	59
450	590	21.9	36.9	37	63
320	1170	20.	73.1	22	78
300	1700	18.75	106.25	15	85
170	2530	10.6	158.1	6	94
347	738	21.7	46.1	32	68
325	920	20.3	57.5	26	74
310	1182	19.4	73.7	21	79
287	1308	17.9	81.9	18	82
267	1798	16.7	112.7	13	87

FOR COMPUTING TOTAL RATION

LAMB

Lamb is leaner and more watery than mutton, but fatter than veal.

	Per cent of water	Calories in each pound	Calories in each ounce
Very lean	72	590	36.9
Lean	68	820	51.2
Medium	64	1050	65.6
Fat	58	1300	81.25
Very fat	52	1590	99.4
Average cuts			
Leg	59	1300	81.25
Side	58	1300	81.25

PORK

Pork is, in general, the fattest of meats.

	Per cent of water	Calories in each pound	Calories in each ounce
Very lean	66	900	56.25
Lean	60	1200	75.
Medium	52	1600	100.
Fat	40	2200	137.5
Very fat	28	2830	176.8
Clear fat	9	3780	236.3
Average cuts			
Feet	55	1400	87.5
Shoulder	51	1690	105.6
Ham	50	1700	106.25
Side	34	2500	156.3
Clear back	25	2970	185.6

Ham and bacon have more salts and less water than fresh pork, but have about the same nutrients and yield substantially the same amount of energy as equally fat pieces of fresh meat.

Sausages differ widely even when called by the same name. Typical examples are:

	Per cent of water	Calories in each pound	Calories in each ounce
Bologna	60	1090	68.1
Pork	40	2120	132.5

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in		Calories of energy in each ounce contained in		Per cent of total energy contained in	
Proteins	Fats	Proteins	Fats	Proteins	Fats
465	125	29.1	7.8	79	21
400	420	25.	26.2	49	51
350	700	21.9	43.7	33	67
330	970	20.6	60.6	25	75
310	1280	19.4	80.	20	80
346	954	21.6	59.6	27	73
326	974	20.4	60.9	25	75
370	530	23.1	33.1	41	59
350	850	21.85	53.1	29	71
300	1300	18.75	81.25	19	81
250	1950	15.6	121.9	11	89
110	2720	6.9	170.	4	96
70	3710	4.4	231.9	2	98
293	1107	18.3	69.3	21	79
247	1443	15.4	90.2	15	85
292	1408	18.25	88.1	17	83
170	2330	10.6	145.6	7	93
120	2850	7.5	178.1	4	96
350	740	21.9	46.25	32	68
250	1870	15.6	116.9	12	88

FOR COMPUTING TOTAL RATION

FLESH OTHER THAN MUSCLE is much the same in all the domesticated animals. For any creature, averages are

	Per cent of water	Calories in each pound	Calories in each ounce
Kidney	77	510	31.9
Brain	78	600	37.5
Liver[1]	70	660	41.
Heart	70	830	51.9
Gelatin	14	1705	106.3

CLEAR FAT, with connective tissue but no lean:

	Per cent of water	Calories in each pound	Calories in each ounce
Beef suet	13.7	3540	221.25
Salt pork	8.	3670	229.4
Mutton suet	3.4	4060	253.75

CLEAR FAT without connective tissue:

	Per cent of water	Calories in each pound	Calories in each ounce
Oleomargarine	9.5	3525	220.3
Crude lard	4.8	4010	250.6
Refined lard, tallow, etc.		4220	263.75

Butter is nearly like oleomargarine. Olive and cotton seed oils are pure fats like lard and tallow.

[1] Liver contains a carbohydrate, glycogen, amounting on the average to 60 calories in the pound, 3.75 calories to the ounce, and 9 per cent of the total energy. This is here included with the fats.

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in		Calories of energy in each ounce contained in		Per cent of total energy contained in	
Proteins	Fats	Proteins	Fats	Proteins	Fats
310	200	19.4	12.5	61	39
180	420	11.25	26.25	30	70
390	210	24.4	13.1	59	42
325	505	20.3	31.6	39	61
1700	5	106.	.3	100	
80	3460	5.	216.25	2	98
40	3630	2.5	226.9	1	99
30	4030	1.9	251.9	1	99
22	3503	1.4	218.8	1	99
45	3965	2.8	247.8	1	99
0	4220	0.	263.75		100

FOR COMPUTING TOTAL RATION

POULTRY

	Per cent of water	Calories in each pound	Calories in each ounce
Chicken	75	500	31.2
Fowl	64	1050	65.6
Turkey	55	1360	85.

COOKED MEATS

Broiled and roasted meats lose a portion of their water. A portion of the fat also is either lost or transferred to the gravy. Available data for cooked meats is somewhat unreliable.

	Per cent of water	Calories in each pound	Calories in each ounce
Round steak, fat removed	63	840	52.5
Broiled tenderloin steak	55	1300	81.2
Roast beef	48	1620	101.2
Boiled beef tongue	51	1340	83.7
Roast mutton, leg	51	1420	88.7
Roast lamb, leg	67	900	56.2
Broiled lamb chops	48	1665	104.
Ham, rather lean	50	1300	81.2
Deviled ham, canned	44	1790	111.9
Roast pork, rib	34	2050	128.1
Quail	67	775	48.4
Fricasseed chicken	67	855	53.4
Capon	60	985	61.6
Roast turkey	52	1295	80.9

One sandwich, 200 to 400 calories

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in		Calories of energy in each ounce contained in		Per cent of total energy contained in	
Proteins	Fats	Proteins	Fats	Proteins	Fats
400	100	25.	6.2	80	20
365	685	22.8	42.8	35	65
390	970	24.4	60.6	29	71
510	330	31.9	20.6	61	39
445	855	27.8	53.4	34	66
400	1220	25.	76.2	25	75
370	970	23.1	60.6	28	72
460	960	28.7	60.	32	68
360	540	22.5	33.7	40	60
405	1260	25.3	78.7	24	76
425	875	26.6	54.7	33	67
355	1435	22.2	89.7	20	80
460	1590	28.7	99.4	22	78
410	335	25.6	20.9	53	43
325	485	20.3	30.3	38	57
500	485	31.2	30.3	51	49
525	770	32.8	48.1	40	60

FOR COMPUTING TOTAL RATION

SOUPS AND STEWS

These, even when called by the same name, vary within wide limits. Average samples are given here. The flour used for thickening, the various forms of starch commonly added, together with some glycogen are here included with the fats.

	Per cent of water	Calories in each pound	Calories in each ounce
Bouillon, consommé, and julienne	96	55	3.4
Chicken	94	100	6.2
Beef	93	120	7.5
Chicken gumbo, mock turtle, mulligatawny	89	185	11.6
Clam chowder	89	195	12.2
Ox tail	89	210	13.1
Green turtle	87	265	16.6
Meat stew	85	370	23.1
Vegetable soups, pea, bean, cream of celery, asparagus, etc., average	86	250	15.6

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in		Calories of energy in each ounce contained in		Per cent of total energy contained in	
Proteins	Fats	Proteins	Fats	Proteins	Fats
38	12	2.4	1.	70	30
57	43	3.6	2.6	57	43
75	45	4.7	2.8	60	40
93	92	5.8	5.8	50	50
37	138	2.3	9.9	29	71
75	135	4.7	8.4	35	65
112	153	7.	9.6	42	54
93	277	5.8	17.3	25	75
38	212	2.4	13.2	15	85

FOR COMPUTING TOTAL RATION

FRESH FISH

	Per cent of water	Calories in each pound	Calories in each ounce
Flounder	84	290	18.2
Hake	83	315	19.7
Cusk	82	325	20.3
Cod	83	325	20.3
Haddock	82	335	20.8
Blackfish	80	405	25.3
Red snapper	78.5	410	25.6
Brook trout	78	445	27.8
Black bass	77	455	28.4
Halibut	75	565	35.3
Cisco	74	630	39.4
Mackerel	73	645	40.3
Eels	72	730	45.6
Shad	71	750	46.9
Lake trout	71	765	47.8
Butter fish	70	800	50.0
Turbot	71	885	55.3
Salmon	65	950	59.4

PRESERVED FISH

Fish is, in general, so watery that it is much altered by either salting or smoking. Common salt may reach ten or twenty per cent. In canning vegetable oils are often added.

	Per cent of water	Calories in each pound	Calories in each ounce
Smoked haddock	73	440	27.5
Salt cod	54	450	28.1
Canned salmon	64	915	57.2
Smoked halibut	50	1020	63.8
Canned sardines	52	1260	78.8
Salt mackerel	42	1345	84.1
Smoked herring	35	1355	84.7

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in		Calories of energy in each ounce contained in		Per cent of total energy contained in	
Proteins	Fats	Proteins	Fats	Proteins	Fats
265	25	16.6	1.6	91	9
280	35	17.5	2.2	89	11
317	8	19.8	.5	98	2
308	17	19.25	1.1	95	5
322	13	20.	.8	96	4
350	55	21.9	3.4	85	14
367	43	22.9	2.7	90	10
355	90	22.2	5.6	80	20
383	72	23.9	4.5	84	16
345	220	21.6	13.7	61	39
340	290	21.25	18.1	54	46
345	300	21.6	18.7	53	47
345	385	21.6	24.1	47	53
350	400	21.9	25.	47	53
330	435	20.6	27.2	43	57
335	465	20.9	29.1	42	58
275	610	17.2	38.1	31	69
410	540	25.6	33.7	43	57
432	8	27.	.5	98	2
437	13	27.3	.8	97	3
410	505	25.6	31.6	45	55
385	635	24.1	39.7	38	62
430	830	26.9	51.9	34	66
390	955	24.4	59.7	29	71
680	675	42.5	42.2	50	50

FOR COMPUTING TOTAL RATION

SHELL FISH, ETC.

Several of these contain also starch, largely the glycogen of the liver, up to nearly five per cent. This is here lumped in with the other non-nitrogenous nutrients as "fats."

	Per cent of water	Calories in each pound	Calories in each ounce
Frogs' legs	84	295	18.4
Round clams	86	215	13.4
Oysters	87	235	14.7
Long clams	86	240	15.
Mussels	84	285	17.8
Scallops	80	345	21.6
Lobster	79	390	24.4
Hard shell crab	77	415	25.9
Green turtle	80	390	24.4
Terrapin	75	545	34.1

EGGS

	Per cent of water	Calories in each pound	Calories in each ounce
Without shell	74	720	45.
Shell included	65	635	39.7
White only	86	250	15.6
Yolk only	50	1705	106.3

One egg, 70 to 100 calories

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in		Calories of energy in each ounce contained in		Per cent of total energy contained in	
Proteins	Fats	Proteins	Fats	Proteins	Fats
285	10	17.8	.6	97	3
120	95	7.5	5.9	56	44
115	120	7.2	7.5	49	51
160	80	10.	5.	67	33
160	125	10.	7.8	56	44
280	65	17.5	4.1	81	19
300	90	18.75	5.6	77	23
315	100	19.7	6.25	76	24
350	40	21.9	2.5	90	10
390	155	24.4	9.7	72	28
275	445	17.2	27.8	38	62
245	390	15.3	24.4	38	62
242	8	15.1	.5	97	3
300	1405	18.75	87.5	17	83

FOR COMPUTING TOTAL RATION

MILK AND CREAM

The carbohydrate of milk and its derivatives is milk sugar, but certain tinned milks are nearly half cane sugar. Koumiss also has cane sugar up to about five per cent, and alcohol up to one per cent.

	Per cent of water	Calories in each pound	Calories in each ounce
Whey	93	125	7.8
Buttermilk	91	165	10.4
Skimmed milk	90	170	10.6
Koumiss	89	240	15.
Whole milk	87	325	20.1
Evaporated milk, unsweetened	68	780	48.7
Cream	74	910	56.9
Condensed milk, sweetened	27	1520	95.

CHEESE AND BUTTER

Most cheeses lose water slowly with age, commonly to the amount of two or three per cent. Milk sugar and lactic acid are the carbohydrates.

	Per cent of water	Calories in each pound	Calories in each ounce
Cottage	72	510	31.9
Brie	60	1210	75.6
Skimmed milk	46	1320	82.5
Dutch	35	1435	89.7
Neuchatel	50	1530	95.6
Roquefort	39	1700	106.2
American full cream	34	1950	121.9
Swiss	31	2010	125.6
Cheddar	27	2145	134.
Butter	11	3605	225.2

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in			Calories of energy in each ounce contained in			Per cent of total energy contained in		
Proteins	Fats	Sugars	Proteins	Fats	Sugars	Proteins	Fats	Sugars
19	13	93	1.2	.8	5.8	15	10	75
56	21	89	3.5	1.3	5.6	34	13	53
63	13	95	3.9	.8	5.9	37	7	56
52	89	100	3.2	5.6	6.2	22	37	41
61	169	93	3.8	10.5	5.8	19	52	29
179	392	208	11.2	24.5	13.	23	50	27
46	781	84	2.9	48.7	5.2	5	86	9
164	350	1006	10.3	21.9	62.8	11	23	66
389	42	80	24.3	2.6	5.	76	8	16
296	886	26	18.5	55.4	1.6	25	73	2
586	692	41	36.6	43.2	2.6	44	53	3
690	747	–	43.1	46.6	–	48	52	–
348	1156	28	21.7	72.2	1.7	23	75	2
420	1245	33	26.2	77.9	2.1	25	73	2
482	1422	45	30.1	89.	2.8	25	73	2
513	1473	24	32.1	92.	1.5	26	73	1
515	1553	76	32.1	97.	4.8	23	73	4
19	3587	–	1.2	224.	–	0.5	99.5	–

FOR COMPUTING TOTAL RATION

FLOURS AND MEALS

Nearly all vegetable foods contain one or two per cent of mineral matter. Many of them have also one or two per cent of crude fiber which is not digestible.

The carbohydrates of the grains are largely starch. With this is included the fiber, and one or two per cent of dextrin and various sugars.

	Per cent of water	Calories in each pound	Calories in each ounce
Barley meal and flour	12	1640	102.5
Buckwheat flour	14	1620	101.2
Corn meal	12.5	1655	103.4
Hominy	12	1650	103.2
Oatmeal	7	1860	116.2
Oat preparations, breakfast foods	8	1850	115.6
Rice	12	1630	101.9
Rye flour	13	1630	102.
Wheat flour, white	12	1650	103.1
Graham flour	11	1670	104.4
Entire wheat flour	11	1675	104.8
Wheat preparations, breakfast foods, etc	10	1700	106.2
Macaroni, spaghetti, noodles, etc.	11	1660	103.7
Sago	12	1635	102.2
Infants' foods, invalids' foods, malted milk, and the like, are all pretty much the same thing and average	6	1795	112.2

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in			Calories of energy in each ounce contained in			Per cent of total energy contained in		
Proteins	Fats	Starch	Proteins	Fats	Starch	Proteins	Fats	Starch
195	93	1352	12.2	5.8	84.4	12	6	82
119	51	1450	7.4	3.2	90.6	7	3	90
171	80	1404	10.7	5.	87.7	10	5	85
155	25	1470	9.7	1.6	91.9	9	2	89
300	304	1256	18.7	19.	78.5	16	16	68
307	308	1235	19.2	19.2	77.2	17	17	66
149	13	1468	9.3	.8	91.7	9	1	90
126	38	1466	7.9	2.4	91.6	8	2	90
212	42	1396	13.3	2.6	87.2	13	3	84
247	93	1330	15.4	5.8	83.1	15	6	79
257	80	1338	16.1	5.	83.6	15	5	80
225	76	1399	14.1	4.7	87.4	13	5	82
205	63	1392	12.8	3.9	87.	12	4	84
168	17	1450	10.5	1.1	90.6	10	1	89
237	140	1418	14.8	8.7	88.7	14	7	79

FOR COMPUTING TOTAL RATION

MUSHES, GRUELS, AND COOKED BREAKFAST FOODS

These are easily computed from the formula of the dry cereal by dividing the percentages of proteins, fats, and carbohydrates, and the total food units, by a number greater by one than the number of parts of water added to the dry substance. If, for example, two parts of water are added to one of the cereal, all quantities, except the percentage of water, are divided by three, since the resulting dish is only one-third strength. The following are given for convenience.

	Per cent of water	Calories in each pound	Calories in each ounce
Oat meal water	96	70	4.4
Oatmeal milk gruel	92	155	9.7
Boiled oatmeal	85	285	17.8
Cream of wheat	84	285	17.8
Hominy	80	380	23.8
Boiled rice	73	510	31.9
Shredded wheat biscuit, each one ounce	10	1700	106.3

All the innumerable wheat preparations have virtually the same composition as shredded wheat. They differ from common wheat flour only in being slightly drier, so that, with two per cent less water, they have a total nutrition of fifty more calories to the pound. Cooked with one part of the dry cereal to five parts of water, they all become virtually identical with oatmeal and cream of wheat as here given. The rice of this table is cooked with the least possible water, so that grains remain separate. As more commonly prepared, it is about like wheat and oats.

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in			Calories of energy in each ounce contained in			Per cent of total energy contained in		
Proteins	Fats	Starch	Proteins	Fats	Starch	Proteins	Fats	Starch
13	4	53	.8	.3	3.3	19	6	75
22	17	116	1.4	1.1	7.2	14	11	75
52	21	212	3.2	1.3	13.3	18	7	75
37	13	235	2.3	.8	14.7	13	5	82
41	8	331	2.6	.5	20.7	11	2	87
52	4	454	3.2	.3	28.4	10	1	89
225	76	1399	14.1	4.7	87.5	13	5	82

FOR COMPUTING TOTAL RATION

VARIOUS FORMS OF SUGAR

All these are virtually sugar or sugar and water, with less than one per cent of other substances. All are entirely cane sugar, except honey and candy. Honey is about equal parts fruit sugar and grape sugar, *i. e.*, levulose and glucose, with less than three per cent cane sugar. Candies are largely cane sugar, with ten or twenty per cent of other sugars mostly glucose. Certain kinds, marshmallows, caramels, chocolate creams, for example, are sometimes a quarter or even a half starch.

	Per cent of water	Calories in each pound	Calories in each ounce
Molasses	25	1290	80.6
Maple sirup	30	1330	83.1
Honey	18	1520	95.
Maple sugar	13	1540	96.25
Brown sugar	5	1765	110.3
Candy	4	1785	111.5
White sugar	0	1860	116.2

PREPARED STARCH

These are virtually pure starch with a little water.

	Per cent of water	Calories in each pound	Calories in each ounce
Tapioca	11	1650	103.1
Manioca	10	1665	104.
Cornstarch	10	1675	104.6
Arrowroot	2	1815	113.5

FOR COMPUTING THE RATION BALANCE

SUGAR ONLY

STARCH ONLY

FOR COMPUTING TOTAL RATION

BREAD AND CRACKERS

The composition of these depends less on the kind of flour than on the proportions of milk and water, and still more on the amount of shortening. Any particular recipe is easily figured from the ingredients. The following are standard sorts.

	Per cent of water	Calories in each pound	Calories in each ounce
Brown	44	1050	65.6
Rye	36	1180	73.8
Corn	40	1205	75.4
Entire wheat	38	1140	71.3
Graham	36	1210	75.6
White	35	1215	75.9
	One slice bread, 1½ ounces, 100 calories		
Rolls	29	1395	87.1
	One roll, two ounces, 175 calories		
Toast	24	1420	88.7
Sugar buns	30	1450	90.6
Pretzels	10	1700	106.3
Pilot bread	9	1800	112.5
	One pilot cracker, 1¾ ounces, 200 calories		
Soda crackers	6	1925	120.3
Zweiback	6	1970	123.1
Saltines	6	2005	125.3

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in			Calories of energy in each ounce contained in			Per cent of total energy contained in		
Proteins	Fats	Starch	Proteins	Fats	Starch	Proteins	Fats	Starch
100	76	874	6.3	4.7	54.6	10	7	83
167	25	988	10.5	1.6	61.8	14	2	84
147	198	860	9.2	12.4	53.8	12	16	72
180	38	922	11.3	2.4	57.7	16	3	81
165	76	969	10.3	4.7	60.6	14	6	80
171	55	989	10.7	3.4	61.8	14	5	81
166	173	1056	10.4	10.8	65.9	12	12	76
214	68	1138	13.3	4.2	71.2	15	5	80
151	291	1008	9.4	18.2	63.1	10	20	70
180	165	1355	11.3	10.3	84.7	11	10	79
205	212	1383	12.8	13.2	86.4	11	12	77
181	384	1360	11.3	24.	85.	9	20	71
182	418	1370	11.4	26.1	85.6	9	21	70
197	536	1272	12.3	33.5	79.4	10	26	64

FOR COMPUTING TOTAL RATION

CAKES AND COOKIES

	Per cent of water	Calories in each pound	Calories in each ounce
Baker's cake	31	1370	85.6
Cream pie	32	1515	94.7
Chocolate layer cake	20	1650	103.
Gingerbread	19	1670	104.4
Lady fingers	15	1685	105.3
Frosted cake	18	1695	105.9
Fruit cake	17	1760	110.
Sponge cake	15	1795	112.2
Ginger snaps	6	1895	118.4
Molasses and sugar cookies	8	1910	119.4
One cookie, one dozen to the pound, 160 calories			
Wafers	7	1985	124.
Doughnuts	18	2000	125.
One doughnut, two ounces, 250 calories			

PUDDINGS AND PIES

	Per cent of water	Calories in each pound	Calories in each ounce
Apple tapioca pudding	70	555	34.7
Plain tapioca pudding	65	720	45.
Indian meal pudding	60	815	50.9
Rice custard pudding	60	825	51.5
Custard or squash pie	63	830	51.9
Lemon pie	47	1190	74.4
Apple pie	43	1270	79.4
Mince pie	41	1335	83.4
Raisin pie	37	1410	88.1

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in			Calories of energy in each ounce contained in			Per cent of total energy contained in		
Proteins	Fats	Starch-Sugars	Proteins	Fats	Starch-Sugars	Proteins	Fats	Starch-Sugars
117	194	1059	7.3	12.1	66.2	9	14	77
82	481	952	5.1	30.1	59.5	5	32	63
115	342	1191	7.2	21.4	74.4	7	21	72
108	380	1182	6.7	23.7	73.8	6	23	71
163	211	1311	10.2	13.2	81.9	10	12	78
110	380	1205	6.9	23.7	75.3	6	23	71
110	460	1190	6.9	28.7	74.4	6	26	68
117	452	1226	7.3	28.2	76.6	6	25	69
121	362	1412	7.6	22.6	88.1	6	19	74
130	409	1371	8.1	25.6	85.6	7	21	72
141	489	1355	8.8	30.6	84.7	7	25	68
125	887	988	7.8	55.4	61.8	6	44	49
6	4	545	.4	.2	34.1	1	1	98
61	135	524	3.8	8.4	32.8	8	19	73
102	202	511	6.4	12.6	31.9	12	25	63
75	180	570	4.7	11.2	35.6	9	22	69
78	266	486	4.9	16.6	30.4	9	32	58
67	427	696	4.2	26.7	43.5	6	36	58
58	414	798	3.6	25.9	49.9	4	33	63
108	519	708	6.7	32.4	44.3	8	39	53
56	476	878	3.5	29.7	54.9	4	34	62

FOR COMPUTING TOTAL RATION

NUTS

	Per cent of water	Calories in each pound	Calories in each ounce
Fresh chestnuts	45	1125	70.3
Dried chestnuts	6	1875	117.1
Peanuts	9	2560	160.
Peanut butter	2	2825	176.6
Fresh cocoanut	14	2760	172.5
Prepared cocoanut	4	3125	195.3
Almonds	5	3030	189.4
Pine nuts	5	3040	190.
Butternuts	4	3165	197.8
Brazil nuts	5	3265	204.
Walnuts	3	3280	205.
Pecans	3	3445	215.3
Malted nuts	3	2420	151.2
Cocoa	5	2320	145.
Chocolate	6	2860	178.7

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in			Calories of energy in each ounce contained in			Per cent of total energy contained in		
Proteins	Fats	Starch-Sugars	Proteins	Fats	Starch-Sugars	Proteins	Fats	Starch-Sugars
115	228	784	7.2	14.2	49.	10	18	72
199	295	1381	12.4	18.4	86.3			
480	1626	454	30.	101.5	28.4	19	67	14
545	1962	318	34.1	122.6	19.9			
106	2135	519	6.6	133.4	32.4	4	77	19
117	2422	586	7.3	151.3	36.6			
391	2317	322	24.4	144.9	20.1	13	76	11
430	2330	280	26.9	145.6	17.5	14	77	9
519	2581	65	32.4	161.3	4.1	16	82	2
316	2819	130	19.8	176.1	8.1	10	86	4
309	2672	299	19.3	167.	18.7	9	82	9
186	2999	260	11.6	187.4	16.3	5	87	8
440	1165	815	27.5	72.8	50.9	18	48	34
400	1220	700	25.	76.3	43.7	17	53	30
240	2056	564	15.	128.5	35.2	8	72	20

FOR COMPUTING TOTAL RATION

FRESH FRUITS

The carbohydrates of fruit are largely grape and fruit sugars; with this there are various fruit acids and often two or three per cent of fiber.

	Per cent of water	Calories in each pound	Calories in each ounce
Watermelon	92.4	140	8.7
Strawberries	90	180	11.3
Muskmelon	89	185	11.6
Peaches	89	190	11 9
Oranges	87	240	15.
Apricots	85	270	16.9
Apples	85	290	18.1
Pears	84	295	18.4
Raspberries	84	305	19.1
Cherries	81	365	22.8
Fresh figs	79	380	23.7
Plums	78	395	24.7
Grapes	77	450	28.1
Bananas	75	460	28.7

One large apple or orange, 100 calories

DRIED FRUITS

	Per cent of water	Calories in each pound	Calories in each ounce
Apples	28	1350	84.4
Prunes	22	1400	87.5
Figs	19	1475	92.2
Currants	17	1495	93.4
Raisins	15	1605	100.
Dates	15	1615	101.
Fruit jellies	30	1320	82.5
Orange marmalade	15	1585	99.
Ripe olives	65	1205	75.3
Green olives	58	1400	87.5
Olive and cotton seed oil	00	4225	264.1

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in			Calories of energy in each ounce contained in			Per cent of total energy contained in		
Proteins	Fats	Starch-Sugars	Proteins	Fats	Starch-Sugars	Proteins	Fats	Starch-Sugars
7	8	125	.4	.5	7.8	5	6	89
19	25	136	1.2	1.7	8.5	10	14	76
11	–	174	.7	–	10.9	6	–	94
13	4	173	.8	.3	10.8	7	2	91
15	8	217	.9	.5	13.6	6	3	90
20	–	250	1.3	–	15.6	7	–	93
7	21	262	.4	1.3	16.4	2	7	91
11	21	263	.7	1.3	16.4	4	7	89
28	42	235	1.8	2.6	14.7	9	14	77
19	34	312	1.2	2.1	19.5	5	10	85
28	–	352	1.8	–	21.9	7	–	92
19	–	375	1.2	–	23.4	5	–	95
24	68	358	1.5	4.2	22.4	5	15	80
24	25	411	1.5	1.6	25.7	5	6	89
30	93	1227	1.9	5.8	76.6	2	7	91
39	–	1363	2.4	–	85.2	3	–	97
80	13	1382	5.	.8	86.3	5	1	94
45	72	1378	2.8	4.5	86.2	3	5	92
48	139	1413	3.	8.7	88.3	3	9	88
39	118	1458	2.4	7.4	91.1	2	7	91
20	–	1300	1.3	–	81.2	1	–	99
11	4	1570	.7	.2	98.1	1	–	99
32	1093	80	2.	68.3	5.	3	90	7
20	1165	215	1.3	72.8	13.4	1	83	15
–	4225	–	–	264.1	–	–	100	

FOR COMPUTING TOTAL RATION

VEGETABLES

The carbohydrates of vegetables are largely starch, with some sugars and commonly one to three per cent of fiber. Different samples differ widely. The following are averages.

	Per cent of water	Calories in each pound	Calories in each ounce
Cucumbers	95	80	5.
Celery	95	85	5.3
Lettuce	95	90	5.6
Asparagus	94	105	6.6
Rhubarb	94	105	6.6
Tomatoes	94	105	6.6
Spinach	92	110	6.9
Pumpkin	93	120	7.5
Radishes	92	135	8.4
Cauliflower	92	140	8.7
Cabbage	91	145	9.1
Turnips	90	185	11.6
String beans	89	195	12.2
Mushrooms	88	210	13.1
Carrots	88	210	13.1
Squash	88	215	13.4
Beets	87	215	13.4
Onions	88	225	14.1
Dandelion greens	81	285	17.8
Artichokes	80	365	22.8
White potatoes	78	385	24.1
Green corn	75	430	26.9
Green peas	75	465	29.1
Sweet potatoes	70	570	35.6
Lima beans	68	570	35.6
Dried beans	13	1605	100.3
Dried lentils	8	1620	101.5
Dried peas	10	1655	103.5

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in			Calories of energy in each ounce contained in			Per cent of total energy contained in		
Proteins	Fats	Starch-Sugars	Proteins	Fats	Starch-Sugars	Proteins	Fats	Starch-Sugars
15	8	57	.9	.5	3.6	19	11	70
20	4	61	1.2	.3	3.8	23	5	72
22	13	55	1.4	.8	3.4	24	14	62
34	9	62	2.1	.6	3.9	32	9	59
11	30	64	.7	1.9	4.	10	29	61
17	17	71	1.1	1.1	4.4	16	16	68
39	13	58	2.4	.8	3.6	35	12	53
20	5	95	1.2	.3	5.9	17	4	79
24	4	107	1.5	.3	6.7	18	3	79
33	21	86	2.1	1.3	5.4	24	15	61
30	13	102	1.9	.8	6.4	21	9	70
24	9	152	1.5	.6	9.5	13	5	82
43	13	139	2.7	.8	8.7	22	7	71
65	17	128	4.	1.1	8.	31	8	61
20	17	173	1.2	1.1	10.8	10	8	82
26	21	168	1.6	1.3	10.5	12	10	78
30	4	181	1.9	.3	11.3	14	2	84
30	13	182	1.9	.8	11.4	13	6	81
45	42	198	2.8	2.6	12.4	16	15	69
48	8	309	3.	.5	19.3	13	2	85
41	4	340	2.6	.3	21.2	11	1	88
58	5	367	3.6	.3	22.9	14	1	85
130	21	314	8.1	1.3	19.6	28	5	67
33	30	507	2.1	1.8	31 7	6	5	89
132	30	408	8.3	1.8	25.5	23	5	72
419	76	1110	26.2	4.7	69.5	26	5	69
478	42	1100	30.	2.6	68.8	29	3	68
458	42	1155	28.6	2.6	72.2	28	3	69

FOR COMPUTING TOTAL RATION

COOKED VEGETABLES

Certain vegetables take up water when boiled and lose mineral matter and proteins; others cook down to a smaller bulk. The change is not great, and is usually masked by the addition of butter before serving. The following are sufficiently standardized to be worth quoting.

	Per cent of water	Calories in each pound	Calories in each ounce
Boiled or steamed potatoes	76	440	27.5
Mashed and creamed potatoes	75	505	31.6
Potato cakes	74	515	32.2
Baked potatoes	73	525	32.7
Baked beans	69	600	37.5

Fried vegetables lose water and take up fat. An extreme case is:

	Per cent of water	Calories in each pound	Calories in each ounce
Potato chips	2	2675	167.2

Vegetable soups vary widely and are best computed from the ingredients. Examples are:

	Per cent of water	Calories in each pound	Calories in each ounce
Pea	87	240	15.
Purée of vegetable	89	250	15.6

FOR COMPUTING THE RATION BALANCE

Calories of energy in each pound contained in			Calories of energy in each ounce contained in			Per cent of total energy contained in		
Proteins	Fats	Starch-Sugars	Proteins	Fats	Starch-Sugars	Proteins	Fats	Starch-Sugars
47	4	389	2.9	.3	24.3	11	1	88
48	127	330	3.	7.9	20.6	10	25	65
48	132	355	3.	8.3	20.9	9	26	65
54	6	465	3.4	.4	28.9	11	1	88
128	105	367	8.	6.6	22.9	21	18	61
126	1680	869	7.9	105.	54.3	5	63	32
66	34	140	4.1	2.1	8.8	27	14	59
39	118	93	2.4	7.4	5.8	16	47	37

FOR COMPUTING TOTAL RATION

DRINKS

	Calories in one pound	Calories in one glass or cup, six ounces
Tea and coffee		0
Tea with milk and sugar		50
Cereal coffees		11
Coffee and cereal coffees with cream and sugar		100
Beef tea	40	15
Oatmeal water	70	26
Egg water	75	28
Whey	125	47
Apple juice	130	49
Skimmed milk	170	64
Lemonade	180	67
Beer	200	75
Koumiss	240	90
Milk	325	122
Cocoa, one-half milk	350	130
Grape juice	380	142
Chocolate, all milk	570	214

INDEX

INDEX

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